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PHYSIOLOGICAL ASPECTS
OF
THE LIQUOR PROBLEM

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INVESTIGATIONS MADE BY AND
UNDER THE DIRECTION OF

W. O. ATWATER, JOHN S. BILLINGS,
H. P. BOWDITCH, R. H. CHITTENDEN,
AND W. H. WELCH

SUB-COMMITTEE OF THE COMMITTEE OF FIFTY TO
INVESTIGATE THE LIQUOR PROBLEM

VOLUME I

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NOTE.

THE publication of the series of reports on various aspects of the Liquor Problem of which these volumes form the fourth was begun in 1897 with that on "The Liquor Problem in its Legislative Aspects," prepared under the direction of Pres. Charles W. Eliot, Pres. Seth Low, and Hon. James C. Carter, a sub-committee of the Committee of Fifty. Then followed in 1899, "Economic Aspects of the Liquor Problem," under the direction of Henry W. Farnam, Secretary of the Economic Sub-Committee, and in 1901, "Substitutes for the Saloon," under the direction of the Ethical Sub-Committee, consisting of Prof. Francis G. Peabody, Dr. Elgin R. L. Gould, and Prof. William M. Sloane. Like its predecessors, this report is preliminary in its nature, and is published in accordance with a vote of the Committee of Fifty passed January 10, 1896, by which "reports by its sub-committees to the whole body may be published by authority of the Executive Committee as contributions to the general inquiry, but to all such publications is to be prefixed a statement that reports of sub-committees are to be regarded as preliminary in their nature, and only contributory of facts upon which the general discussion may in the future be undertaken by the committee as a whole."

CONTENTS OF VOLUME I.

REPORT OF THE SUB-COMMITTEE ON THE

PHYSIOLOGICAL AND PATHOLOGICAL ASPECTS OF THE DRINK PROBLEM,

PRESENTED TO THE

COMMITTEE OF FIFTY.

REPORT.

At the meeting for the organization of the Committee of Fifty, held in April, 1893, the following named gentlemen were appointed a Committee on the Physiological and Pathological Aspects of the Drink Problem, namely, Dr. J. S. Billings, U. S. Army, Director of the Medical Museum and Library, Washington; General Francis A. Walker, President of the Massachusetts Institute of Technology; and Professor R. H. Chittenden, Director of the Sheffield Scientific School of Yale University. This committee was requested to report to the General Committee as to what investigations should be made into the effects of alcoholic drinks upon the human body, in order to settle, as far as possible, the questions as to the nature and amount of such effects, and to lead to a sound judgment as to the merits of the widely divergent opinions with regard to the effects of the moderate use of alcoholic drinks which are at present found among writers and teachers on this subject.

In the following month, May, 1893, a report was presented to the committee, stating that investigations are needed upon the following subjects: —

"I. The effects of each usual, or, as it might be termed, normal constituent of various kinds of alcoholic drinks, including more especially malt liquors, the wines in ordinary use, whiskeys, brandy, rum, gin, and liquors or cordials. The constituents referred to are ordinary or ethyl alcohol, various higher alcohols, such as amyl, propyl, butyl, etc., alcohol and their derivative ethers, extractive, bitter, aromatic, and coloring matters, volatile oils, tannin, salicylic acid, and other preservatives, etc.

"II. The effects of certain unusual and abnormal substances which are at times found in alcoholic drinks, and which may be either purposely added or be accidental contaminations.

"III. The effect of the various combinations of these normal and abnormal constituents which form the alcoholic drinks of commerce.

"IV. The effects to be observed may be divided into immediate, secondary, and remote. The immediate and secondary effects, such as those on body temperature, digestion, absorption, secretion, the vascular and nervous systems, and especially on metabolism or nutrition in general, are to be ascertained by experiments on animals and on man. By secondary effects are meant those which follow within a day or two. This investigation would chiefly be a matter for skilled experimental physiologists to undertake.

"V. The remote effects are those due to the action for a considerable period of time of the substances in question, being manifested by changes in tissues, organs, and functions, together with the resultant influence on nutrition produced by a more or less habitual use of alcoholic drinks of various kinds. This branch of the inquiry pertains more especially to pathology, and requires a careful collection and comparison of records by competent observers. Experiment on this part of the question has but a limited field of usefulness, although the results bearing on nutrition may be of direct value.

"VI. It is believed in a general way that the results of the habitual use of the different kinds of alcoholic drinks differ in different individuals, and also according to the form and amount of drink used. Thus physicians commonly believe that the habitual excessive use of malt liquors tends to produce fatty degenerations of various organs, more especially of the liver and kidneys; that the habitual use of wine, more especially of burgundy, and the finer clarets and port, tends to produce gout; that the excessive use of distilled liquors tends to produce excessive development of the inter-cellular tissue in the liver and kidneys, resulting in what is called cirrhosis; and that the use of the cheaper kinds of spirits, and especially of those containing the higher kinds of alcohols in the form of fusel oil, is especially likely to produce delirium tremens. At present, however, such statements as these are usually matters of individual opinion and do not rest upon any scientific statistical basis. One of the lines of inquiry would be to obtain positive data on these points, to compare the results observed in beer drinkers, for example, with those observed in spirit drinkers.

"VII. Another branch of the inquiry into remote effects relates to the influence upon offspring of the habitual use of

alcohol, or of its excessive use just prior to fecundation and during pregnancy. Upon these points we have little definite and accurate information. Connected with this is the question of hereditary predisposition to alcoholism, and that of periodical alcoholism or so-called dipsomania, in which the desire for alcoholic drinks is considered to be due to abnormal nerve structure, and to be, therefore, a symptom of a particular form of disease.

"VIII. In each of these lines of inquiry, the first step should be to prepare a concise statement of what is known, carefully distinguishing facts reported by reliable experimenters and observers and paying little attention to speculations and theories, except for the purpose of formulating definite questions with an indication of the possible sources from which positive answers may be derived. This part of the work can probably be best done in the library of the Surgeon-General's office in Washington, and it would occupy the time of a skilled man for several months."

The general conclusions of this report were approved by the main committee. The Committee on the Physiological and Pathological Aspects of the Drink Question was continued, and Professor H. P. Bowditch of the Harvard Medical School, Boston; Dr. William H. Welch, Professor of Pathology in Johns Hopkins University, Baltimore; and Dr. G. Alder Blumer, Director of the State Insane Asylum, Utica, N. Y., were added to the committee, which, somewhat later, was increased by the addition of Dr. W. O. Atwater, Professor of Chemistry in Wesleyan University, Middletown, Conn. The committee thus organized proceeded to enter on the following investigations: —

I. A research on the influence of pure ethyl alcohol and some alcoholic drinks upon the purely chemical processes of digestion, carried out under the direction of Professor R. H. Chittenden:

II. A research upon the pathological effects on the tissues produced by the long-continued use of alcoholic drinks, made under the direction of Professor W. H. Welch;

III. A research on the influence of alcoholic drinks and of pure ethyl alcohol upon the growth and development of certain animals, made under the direction of Dr. C. F. Hodge, Professor of Physiology in Clark University, Worcester, Massachusetts;

IV. The preparation of a bibliography of the most important literature on the effects of alcoholic drinks, by Dr. Billings;

V. The preparation and issue of schemes for the collection of certain data with regard to the use of alcoholic drinks.

At the meeting of the Committee of Fifty, November 16, 1894, the Sub-Committee on the Physiological and Pathological Aspects of the Drink Question presented a report, showing that the various special researches above named were being carried on. The preliminary bibliography of the literature on the effects of alcohol and alcoholic drinks had been printed. It also called attention to the following facts: —

"That the experimental researches which have been ordered or proposed, important as they are, will have only an indirect bearing upon some of the most important questions to be considered by the Committee of Fifty, such, for example, as the following: —

"I. To what extent does each alcoholic drink in ordinary use, more especially wine, beer, and whiskey, produce disease and shorten life in the United States, or in certain localities in the United States?

"II. What are the particular forms of disease which each class of alcoholic drinks specially tends to produce, and to what special constituent of the drink are these peculiar effects due?

"III. Is the regular consumption of a moderate quantity of wine, beer, or whiskey conducive to the maintenance of health and the working power in any class of men? If so, what class, and what is the average quantity that is thus useful?

"IV. What is the quantity of whiskey, wine, or beer, which the average man in good health may consume daily, without special risk of injuring his health? Does this vary in connection with variations of age, of climate, or of occupation, and, if so, what are these variations?

"The laboratory researches authorized or proposed by the committee bear mainly upon question II. With regard to the other questions it proposes to attempt to obtain information by the collection of statistical data, and for this purpose it proposes to undertake four lines of inquiry, as follows: —

"I. To address a circular letter to a large number of men in various parts of the country who are above forty years of age,

and are engaged in mental work of a high class, inclosing a form to be filled out embracing a series of questions with regard to the use of alcoholic drinks by, and their effects upon, the individual.

"II. A second circular letter with inclosed forms is intended to be addressed to the leading family physicians of the country, to obtain information for each person thirty years of age and upwards under their charge, and with whose habits and physical and mental conditions they are acquainted, giving their habits as to alcoholic drinks and the present condition of their health.

"III. A third line of statistical investigation proposed is to obtain from the large hospitals of the country reports with regard to the habits, use of alcoholic drinks, and the physical and mental condition of patients twenty-five years of age and upwards admitted to them for treatment, the object being to obtain statistics from the class which makes use of hospitals, to compare with those derived from the reports of private physicians. It has not, as yet, been printed.

"In connection with this a scheme has been prepared for a collective investigation of the pathological conditions found in the bodies of those dying while affected with acute or chronic alcoholism, to be sent to large municipal hospitals.

"IV. A fourth line of investigation proposed is with regard to the influence of the use of alcoholic drinks upon the mental condition of those using them, with special reference to the possibility of hereditary transmission of certain mental and physical effects under their influence, and as a commencement of these inquiries it is proposed to gather the data called for from asylums and institutions for the care of the insane. It is believed that this particular branch of the inquiry might well be assigned to the American Medico-Psychological Association, which is composed mainly of superintendents of asylums for the insane, and, on consultation with prominent members of this Association, it is believed they will be willing to undertake it, and also the collection of data called for on the hospital blank form above referred to."

In September, 1895, certain experiments relating to the influence of alcohol upon the process of infection were commenced in the Laboratory of Hygiene of the University of Pennsylvania, by Dr. A. C. Abbott, — the first work relating thereto being on

rabbits under the influence of alcohol to the stage of acute intoxication. The details of these experiments, with the conclusions, were given in a paper which was printed in the "Journal of Experimental Medicine," volume i., No. 3, 1896, and in the "Transactions of the Association of American Physicians," volume ii., page 421. At the same time, it was decided to have a corresponding series of experiments carried out on animals, to ascertain what effects would be produced on the immunity to certain infectious diseases by the long-continued use of alcoholic drinks, and these experiments were undertaken by Dr. Abbott, the animals employed being large monkeys.

The Association of Superintendents of Institutions for the Insane was induced to take up the matter of statistical investigation of the relations between alcohol and insanity, as observed in these institutions. A schedule of questions was prepared and sent out to collect this data.

In the report presented to the General Committee, November 19, 1896, it was stated that it was desirable to have a careful investigation in regard to the metabolism of alcohol and alcoholic drinks in the living human body, as bearing upon the question as to what extent alcohol is consumed in the living human body, thereby acting as a force producer and a food. This investigation was undertaken by Professor Atwater, acting in consultation with the whole committee.

The preliminary report of the results obtained by Professor Hodge was printed in the "Popular Science Monthly" for March, 1897, page 594, and April, 1897, page 796.

Dr. Blumer resigned from the membership of the Committee of Fifty in November, 1897, and his place was filled by the appointment of Dr. P. M. Wise of New York.

At the meeting of the Committee on Ethics in 1896, a report by Mr. Walter A. Wyckoff, prepared under the direction of Professor W. M. Sloane, giving the results of an inquiry into methods of instruction with regard to the effects of alcoholic liquors, and especially the so-called "Scientific Temperance Instruction" formulated by a prominent temperance organization and embodied in various text-books, was, at the request of the Ethical Committee, referred to the Committee on the Physiological and Pathological Aspects of the Drink Question for report, and for the presentation of a scheme of satisfactory

instruction. In considering this question it was apparent that the question as to whether alcoholic drinks are in any sense a food was one of very considerable importance, and one which did not appear to have received such a definite solution as would meet the general approval of scientific physiologists and physicians, although the prevailing opinion among leaders in physiological science is that alcohol is really a food.

Just at this time the opportunity was offered to make a series of experiments upon this point by means of a recently completed calorimeter devised by Professors Atwater and Rosa of Wesleyan University, and the committee, after examining this apparatus and the general plan of investigation proposed by Professor Atwater, were satisfied that in this way a more definite answer to the question could be obtained, and, the necessary funds having been provided by the General Committee, the work was at once commenced and has been continued for some four years. The results were published in detail as a Memoir of the National Academy of Sciences (volume viii., Sixth Memoir, Washington, 1902), entitled "An Experimental Inquiry regarding the Nutritive Value of Alcohol," by W. O. Atwater and F. G. Benedict.

The work which has been done under the general direction of the committee may be summed up as follows: —

I. An investigation on the influence of alcohol and alcoholic drinks upon the chemical processes of digestion, by Professor R. H. Chittenden and Dr. L. B. Mendel.

II. A further study of the influence of alcohol and alcoholic drinks upon digestion with special reference to secretion, by Professor R. H. Chittenden, Dr. L. B. Mendel, and Dr. H. C. Jackson.

III. An investigation on the effects of long-continued doses of alcohol or alcoholic liquors in producing organic changes in certain tissues and organs of the body, made by Professor William Welch and Dr. J. Friedenwald.

In this connection should be mentioned an investigation made by Dr. H. J. Berkley of Baltimore, on the lesions produced by the long-continued use of alcohol on the cortical nerve cells of the brain ("Brain," pt. lxxii., 1895, pp. 473–496, plates), and also one by Colin C. Stewart, on the influence of acute alcoholic poisoning on nerve cells ("Journal of Experimental Medicine," vol. i., 1896, pp. 623–629).

IV. An investigation as to the effects of alcohol and alcoholic drinks on the growth, development, and reproductive powers of animals, by Professor C. F. Hodge of Clark University.

V. An investigation on the influence of alcoholism on infection and immunity, by Professor A. C. Abbott of the University of Pennsylvania.

VI. An investigation of the extent to which alcohol is consumed in the living human body, and its action as a force producer and a food, by Professors W. O. Atwater and F. G. Benedict of Wesleyan University.

VII. An investigation on the relations between the use of alcoholic drinks and insanity, made by the American Medico-Psychological Association.

VIII. A statistical investigation as to the relative prevalence of the use of alcoholic drinks among brain workers in the United States, by Dr. J. S. Billings.

IX. An investigation of the opinions and teachings of leading physiologists and pathologists of the present day, with regard to the effects of alcoholic drinks, and a comparison of these with the teachings of text-books in use in the common schools of this country, by Professors H. P. Bowditch of Harvard and C. F. Hodge of Clark University.

This historical sketch of the development of the plans of research of the Physiological Committee has been given to show that it was clearly recognized that the field for investigation was a very wide one, and that there are many unsettled questions with regard to the physiological and pathological action of alcoholic drinks upon the human body.

With the funds that were available and the number of skilled experimental investigators whose services could be commanded for work of this kind, it was impossible to undertake anything like a complete series of experimental investigations, or reliable and satisfactory statistical inquiries as to the effects produced on man by the moderate use of alcoholic drinks. The committee did not consider it necessary to make special inquiries as to the effects produced on man by what is ordinarily termed an excessive use of liquors, since the evidence that such use tends to produce disease and shorten life has now so accumulated that detailed statistics on this point are unnecessary.

The object which the committee had in view was, as indicated above, to ascertain the effects of the occasional or habitual use of a moderate quantity of wine, beer, or spirits upon the health and working powers of man. As to the term "moderate quantity," the committee accepted the use of this phrase among English physicians as formulated by Anstie, viz., the equivalent of one and one half ($1\frac{1}{2}$) ounces of absolute alcohol per day, or about three (3) ounces of whiskey, or half a bottle of claret or Rhine wine, or four (4) glasses of beer; it being understood that this is to be taken only at lunch and dinner, and that the whiskey is to be well diluted.

CONCLUSIONS.

As the result of their investigations and deliberations the committee have arrived at the following conclusions: —

I. The effects of a moderate or occasional use of alcoholic drinks upon man differ greatly in different individuals, and depend on constitutional peculiarities, age, occupation, climate, etc. Most of them, especially the ultimate effects upon health, cannot be ascertained with much accuracy by experiments upon animals or upon a few men for short periods of time.

II. The results of the many experiments of this kind which have been made up to the present time appear to us to be fairly stated in the papers by Professors Abel, Atwater, Chittenden, and Welch, printed with this report. The committee agree upon the general and more important conclusions of these papers after careful examination and personal conference.

III. We have no trustworthy data as to the proportions of total abstainers, occasional drinkers, regular moderate drinkers, and positively intemperate persons in the United States. From such information as we have, it seems to us probable that of the adult males in this country, not more than twenty per cent. are total abstainers, and not more than five per cent. are positively intemperate in the sense that they drink in such excess as to cause evident injury to health. Of the remaining seventy-five per cent., the majority, probably at least fifty per cent. of the whole, are occasional drinkers, while the remaining twenty-five per cent. might perhaps be classed as regular moderate drinkers.

With the majority of these occasional drinkers, and with many of the regular moderate drinkers, such as those whose

drinking is limited to a glass of wine or two at dinner, no especial effect upon health seems to be observed either by themselves or their physicians, but in some cases the drinking is certainly harmful, while in a few it is thought to be beneficial.

IV. Among the leading brain workers of the United States, as indicated by the statistics in the table on page 313, vol. i., of this report, it would appear that about eighty per cent. use alcoholic drinks occasionally or regularly in moderation. The opinions of these men as to the effects of alcoholic drinks in general have little or no scientific value, but are of interest as showing that the use of such drinks to stimulate mental effort gives, on the whole, bad results.

We believe that such occasional or moderate use is most likely to be harmful to young persons, and mainly because of the danger of its leading to excess; and that the cases where it is useful, otherwise than in disease, are mostly those of persons over fifty years of age and when the alcoholic beverages are taken with the last meal of the day.

V. The special effects of alcoholic drinks are mainly due to the alcohol they contain, and, so far as these effects are harmful, the other substances are of comparatively small importance. Fine old whiskeys and brandies are nearly as likely to produce injurious effects as are the cheaper grades of the same liquors, if taken in the same quantities. Some wines appear to delay or check the digestive process by reason of other constituents than alcohol, as is shown by the experiments of Professor Chittenden with regard to the effects of claret. In general the injurious effect of an alcoholic drink is in proportion to the amount of alcohol contained in it, which seems to be the chief reason why wine and beer are less injurious than distilled liquors.

VI. The question as to whether a given alcoholic drink is a food or a poison is one which cannot be answered by any short comprehensive formula. In moderate quantities, beer, wine, and diluted whiskey are, in a certain sense, foods; but they are seldom used for food purposes, but mainly for their peculiar effects on the brain. In large quantities, and, for a few persons of peculiar temperament, even in moderate quantities, they are poisons.

VII. Alcoholic drinks in moderate quantities may be useful as restoratives in fatigue after the work is done, but they often

produce a depressing and even harmful effect when used just before or during physical or mental labor. They are useless as preventives of infectious or contagious disease; on the contrary, they appear to lessen the power of the organism to resist the effects of the cause of such disease.

VIII. The report prepared by Dr. H. P. Bowditch of Boston, and Professor C. F. Hodge of Worcester, Mass., on the present instruction on the physiological action of alcohol, is believed to be a correct representation of the facts, and to justify the conclusion that much of the methods and substance of the so-called scientific temperance instruction in the public schools is unscientific and undesirable. It is not in accord with the opinions of a large majority of the leading physiologists of Europe as shown by the statement printed on page 18 of volume i. of this Report. This appears to us to be a matter of grave importance.

IX. It does not seem to this sub-committee desirable to attempt to give systematic instruction to all children in the primary schools on the subject of the action of alcohol or of alcoholic drinks. To older children, and especially those in the high schools, it does seem proper that instruction should be given as to the principal facts known about the use and effects of alcoholic drinks, the sociological and especially the ethical relations of the subject, the means which have been tried to prevent the evils resulting from alcoholism — and the results, — the object being to enable them to form an intelligent opinion upon the whole subject, especially to distinguish between mere assertions and scientific evidence.

X. This teaching should not be made a special, isolated matter, but should be a part of some elementary instruction in physiology and hygiene, and all that is really useful and desirable can be given in a brief time, equivalent to a few lessons of an hour each, following the lessons on food. In these lessons might be taught what the ordinary alcoholic drinks are, and of what and how they are made, the difference between simple fermented drinks, like beer and wine, and distilled liquor, such as whiskey, the nature of the so-called "temperance drinks," and the general effects of alcohol as a stimulant and as a narcotic. It might be taught that while in moderate quantities beer and wine may be, in a certain sense, a food, they are a very imperfect and expensive kind of food, and are seldom used for food

purposes: that they are not needed by young and healthy persons, and are dangerous to them in so far as they tend to create a habit; that in certain cases of disease and weakness they are useful in quantities to be prescribed by physicians: that when taken habitually it should be only at meals, and, as a rule, only with the last meal of the day, or soon after it, and that alcoholic drinks of all kinds are worse than useless to prevent fatigue or the effects of cold, although they may at times be useful as restoratives after the work is done.

It should also be taught that alcoholic drinks are almost always a useless expense, that their use in excess is the cause of much disease, suffering, and poverty, and of many crimes; but that such use is sometimes the result, rather than the cause, of disease.

It should not be taught that the drinking of one or two glasses of beer or wine by a grown-up person is very dangerous, for it is not true, and many of the children know by their own home experience that it is not true.

Signed: JOHN S. BILLINGS, *Chairman.*
W. O. ATWATER,
H. P. BOWDITCH,
R. H. CHITTENDEN,
W. H. WELCH.

REPORT

ON THE

PRESENT INSTRUCTION ON THE PHYSIOLOGICAL ACTION OF ALCOHOL.

By DR. H. P. BOWDITCH and DR. C. F. HODGE.

REPORT

ON THE

PRESENT INSTRUCTION ON THE PHYSIOLOGICAL ACTION OF ALCOHOL.

Our sources of information for this report are the following:

First. Standard text-books in common use in colleges, universities, and medical schools.

Second. Letters received from prominent physiologists, both in this country and Europe, giving their opinions on this subject.

Third. Text-books "indorsed and approved" by the "Department of Scientific Temperance Instruction" of the Woman's Christian Temperance Union for use in the public schools.

Fourth. Answers of public school-teachers in reply to questions as to fitness and value of the books and results of so-called "scientific" temperance instruction.

We shall endeavor to treat data from these sources in the above order and in such manner as to show the present status of teaching of the subject. No attempt will be made in this report to harmonize conflicting opinions.

I. STANDARD TEXT-BOOKS OF PHYSIOLOGY.

We shall consider first the various opinions held by physiologists upon the fundamental question of the food value of alcohol and its influence upon the processes and organs of digestion, and shall make but little reference to recent investigations which have not yet found their way into standard text-books, these being fully considered in other reports.

Although his views have not been embodied in a formal text-book, the name of Professor Fick has been long associated with opposition, on physiological grounds, to the use of alcohol.

Fick defines a poison as follows: "We may unhesitatingly designate as a poison any substance which, introduced into the blood in comparatively small amounts, causes disturbances in the functions of any organ. That alcohol is such a substance cannot be doubted."[1] He goes on to explain that alcohol differs from other poisons which affect the nervous system in a way which has led to the erroneous opinion ("irrige Meinung") that alcohol is a food. This difference consists in the fact that alcohol is oxidized in the body. "It is, when introduced into the blood, oxidized like a nutriment, to carbon-dioxide and water, and this oxidation must of course, like the oxidation of albumen, fat, or sugar, produce heat."[2] But this, Fick maintains, does not prove that alcohol can be rightly considered a food unless it be proven that the energy derived from its consumption may be useful to the body. This he does not think clearly demonstrated, and therefore concludes: "Although the relations of the oxidation of alcohol to that of the true nutriments in the animal economy have not yet received a complete physiological explanation, it is certain that alcohol, even when taken in moderation, cannot be classed among the useful nutriments."[3]

Joined with the view of Schmiedeberg, that alcohol exerts only a soothing or narcotic influence upon the nervous system, this position has been adopted by a small group of physiologists. Drs. Gaule, Forel, and Bunge. We have quoted these somewhat guarded statements of Fick, because they are the original

[1] "Als ein Gift werden wir ohne Bedenken jeden Stoff zu bezeichnen haben, der, in verhältnissmässig kleiner Menge dem Blute beigemischt, Storungen in der Verrichtung irgend welches Organs verursacht. Dass der Alkohol ein solcher Stoff ist, kann nicht bezweifelt werden."

[2] "Er verbrennt nämlich, in das Blut eingeführt, wie die Nahrungsstoffe zu Kohlensäure und Wasser, und diese Verbrennung muss natürlich wie die Verbrennung von Eiweiss, Fett oder Zucker Wärme erzeugen."

[3] "Wenn auch die soeben berührten Beziehungen der Verbrennung des Alkohols zur Verbrennung der eigenlichen Nahrungsstoffe im thierischen Organismus physiologisch noch nicht vollständig aufgeklärt sind, das ist gewiss: zu den nützlichen Nahrungsstoffen kann auch der mässig genossene Alkohol nicht gezählt werden."

All the above quotations are from the following: Adolph Fick, *Die Alkoholfrage*, 2d ed., Dresden, 1895, pp. 2–6. A further discussion of this question is given on pp. 20, 21, in connection with the opinions of Professors Kühne, v. Voit, and Dastre, as expressed in their letters.

sources from which the sweeping statements of the school text-books, to receive attention later, have been derived.

Bunge's statement is almost identical with that of Fick. He says : —

"We know that alcohol is mostly oxidized in our body. . . . Alcohol is therefore, without doubt, a source of living energy in our body. But it does not follow from this that it is also a nutriment. To justify this assumption proof must be furnished that the living energy set free by its oxidation is utilized for the performance of a normal function. It is not enough that potential energy is transformed into living energy. The transformation must take place at the right time and place and at definite points in definite elements of the tissues. These elements are not adapted to be fed with every sort of oxidizable material. We do not know whether alcohol can furnish to the muscles and nerves a source of energy for the performance of their functions. . . . In general alcohol has only paralyzing properties," etc.[1]

It will be noted that Bunge does not say that alcohol is not a food, but that it has not been clearly proven to be a food, two clearly distinct positions which are often confused.

The above positions differ but slightly from the four which follow, viz., those of Professors Howell, Schäfer, M. Foster, and Tigerstedt, each one standing for the dictum of one of our best modern scientific writers of physiological text-books.

Professor Howell says: —

"Alcohol also, when not taken in too large quantities, may be oxidized in the body and furnish a not inconsiderable amount of energy. It is, however, a matter of controversy at present whether alcohol in

[1] "Wir wissen, dass der Alkohol zum grössten Theil in unserem Körper verbrannt wird. . . . Der Alkohol ist also zweifellos eine Quelle der lebendigen Kraft in unserem Körper. Daraus folgt aber doch nicht dass er auch ein Nahrungsstoff sei. Um diese Annahme zu begründen, müsste zavor der Nachweis geführt werden, dass die bei seiner Verbrennung frei werdende lebendige Kraft verwerthet werde zur Verrichtung einer normalen Function. Es ist nicht genug, dass chemische Spannkräfte in lebendige Kraft sich umsetzen. Die Umsetzung muss zur rechten Zeit am rechten Orte vor sich gehen, an ganz bestimmten Punkten ganz bestimmter Gewebselemente. Diese Gewebselemente sind gar nicht darauf eingerichtet mit jedem beliebigen Brennmaterial gespeist zu werden. Wir wissen nicht, ob der Alkohol etwa in den Muskeln oder Nerven zur Verrichtung ihrer Functionen die Kraftquelle abgeben könne. . . . Ueberhaupt hat der Alkohol nur lähmende Eigenschaften," etc. G. Bunge, *Lehrbuch der physiologischen und pathologischen Chemie*, Leipzig, 1894, p. 124.

small doses can be considered a true food-stuff capable of serving as a direct source of energy and of replacing a corresponding amount of fats and carbo-hydrates in the daily diet."[1]

Professor Schäfer says: —

"The nutritive value of alcohol has been the subject of considerable discussion and not a few experiments. Some of these tend to show that in moderate non-poisonous doses it acts as a non-proteid food in diminishing the oxidation of proteid, doubtless by becoming itself oxidized. Its action, however, in this respect, is relatively small and, indeed, a certain proportion of the alcohol ingested is exhaled with the air of respiration.

"Moreover, in large doses, it may act in the contrary manner, increasing the waste of tissue proteid. It cannot, in fact, be doubted that any small production of energy resulting from its oxidation is more than counterbalanced by its deleterious influence as a drug upon the tissue elements, and especially upon those of the nervous system.

"It is of interest, in connection with this subject, to point out that alcohol has been regarded by some physiologists as probably formed at a stage in the metabolism of carbo-hydrates prior to their complete oxidation, traces of alcohol having been obtained from fresh tissues by distillation with water."[2]

Professor Tigerstedt says: —

"That alcohol is chiefly oxidized in the body is quite certain. About 10 per cent. of the alcohol taken into the body leaves the body undecomposed. The rest is oxidized to carbon-dioxide and water. But whether this results in a saving of the substances composing the body is difficult to decide, for alcohol, even in comparatively small doses, has a decidedly poisonous effect, and we must therefore consider only those amounts of alcohol by which this effect is not produced.

"If now alcohol is decomposed in the body without protecting other substances from decomposition the excretion of carbon-dioxide should naturally rise in proportion to the amount of alcohol decomposed. This, however, does not seem to be the case. At least, the experiments of Zuntz and Berdez and of Geppert show that the ingestion of a non-toxic dose of alcohol is not followed by any appreciable increase of carbon-dioxide excretion.

"In the normal nutrition of man, however, alcohol can play but a very unimportant part. The amount of alcohol which a man unaccus-

[1] Wm. H. Howell, *American Text-Book of Physiology*, Phila., 1896, p. 297.

[2] E. A. Schäfer, *A Text-Book of Physiology*, 1898, p. 882.

tomed to alcoholic drinks can take without producing symptoms of intoxication is very small, i. e., about 16–25 grams which, reckoning the combustion warmth of alcohol at 7 Calories per gram, would produce 112–175 Calories which amounts to 4.5–7 per cent. of the daily heat production of the body. Only in very exceptional cases can alcohol have any practical importance as a nutriment. It is especially in the case of acute diseases accompanied by diminished digestive power that alcohol, independently of its action on the nervous system, seems to be able to serve as a valuable nutriment."[1]

Professor Foster says: —

"For though observations show that the greater part of a moderate dose of alcohol is oxidized within the body, and so serves as a source of energy, man has recourse to alcohol not for the minute quantity of energy which is supplied by itself, but for its powerful influence on the distribution of energy furnished by other things. . . . For the action of all these bodies of which we are now speaking, in contrast

[1] "Dass der Alkohol zum grössten Theil im Körper verbrannt wird ist ganz sicher. Von dem im Magen aufgenommen Alkohol werden etwa 10 % unzersetzt vom Körper abgegeben, das Uebrige verbrannt zu Kohlensäure und Wasser.

"Ob aber dabei die Körpersubstanz erspart wird ist schwer zu entscheiden, denn der Alkohol übt ja schon in verhältnissmässig kleinen Mengen eine entschieden giftige Wirkung aus, und wir müssen daher nur solche Alkoholmengen in Betracht ziehen, bei welchen jede derartige Wirkung ausgeschlossen ist.

"Wenn nun der Alkohol im Körper zersetzt wird, ohne andere Substanzen vor Zerfall zu schützen, so sollte natürlich die CO_2 Abgabe der Zersetzten Alkoholmengen entsprechend steigen. Dies ist aber nicht der Fall. Wenigstens zeigen die Versuche von Zuntz und Berdez und von Geppert, dass nach Aufnahme einer nicht toxischen Dosis von Alkohol keine nennenswerthe Steigerung der CO_2 Abgabe eintritt.

"Bei der normalen Ernährung des Menschen kann indessen der Alkohol nur eine ganz unbeteudende Rolle spielen. Diejenige Quantität Alkohol, die ein an alkoholische Getränke nicht gewöhnter Mensch geniessen kann ohne dass Vergiftungssymptome auftreten, ist nämlich eine sehr geringe und beträgt nur etwa 16–25 g. was bei einer Verbrennungswarme von 7 W. E. pro g., 112–175 W. E., d. h., bei einem täglichen Bedarf von 2500, W. E., 4.5–7% des Stoffwechsels beträgt. Nur in seltenen Ausnahmsfällen kann der Alkohol als Nahrungsstoff eine practische Bedeutung haben, und zwar vor allem bei akuten, von herabgesetztem Verdaungsvermögen begleiteten Krankheiten. Bei diesen scheint er, unabhängig von seiner Einwirkung auf das Nervensystem, grade als Nahrungsstoff von grossem Nutzen sein zu können." Tigerstedt, *Lehrbuch der Physiologie*, Stockholm, 1898, p. 97.

with the actions of the food-stuffs proper, is not only complex but variable; so complex and variable that simple experience is at present a more trustworthy guide than speculative physiology." [1]

The reader should at this point refer to Dr. Foster's letter, see Appendix I., p. 68, which is in some respects a more explicit statement than the one given in his text-book. This general direction should also be followed with reference to the other authorities whose letters we have been able to obtain.

We have, thus, a group of physiologists at the one extreme who take grounds, more or less strongly, against any dietetic use or value of alcohol, even this group admitting that it is not fully proved that alcohol is not a food. We have a second group who are inclined to favor moderate dietetic use of alcohol, tending to class it with non-proteid foods, but still maintaining that its classification as a food is not clearly established. Among these we should also place Kirkes, whose only reference to alcohol is as follows: —

"Among these" (accessories to food) "must be placed alcohol, the value of which within moderate limits is not as a food but as a stimulant and aid to digestion." [2]

A third group of physiologists and pharmacologists, whether they advocate or oppose its use, evidently consider recent discussions as to the food status of alcohol unnecessary quibbling. For them the evidence is sufficient to pronounce alcohol in moderate quantities a food. The following are citations from authors under this head: —

Sir T. Lauder-Brunton says: —

"The conclusion to which all the evidence points is that alcohol is a food, and in certain circumstances, such as febrile conditions, it may be a very useful food; but in health, when other kinds of food are abundant, it is unnecessary, and, as it interferes with oxidation, it is an inconvenient kind of food." [3]

Professor M'Kendrick says: —

"If oxidized even to a small extent, and the evidence as indicated points to the oxidation of by far the larger proportion of it (95 per

[1] M. Foster, *A Text-Book of Physiology*, 5th ed., Lond., 1891, p. 837.

[2] Kirkes, *Physiology*, Phila., 14th ed., 1896, p. 625.

[3] T. Lauder-Brunton, *A Text-Book of Pharmacology, Therapeutics, and Materia Medica*, Lond., 1887, p. 768.

cent.), alcohol must be regarded in the scientific sense as a food. . . . While, therefore, it must be classed technically as a food, it is in many respects an unsuitable food and its place can be taken with great advantage by other substances." [1]

Professor G. N. Stewart says: —

"In small quantities alcohol is oxidized in the body, a little of it, however, being excreted unchanged in the breath and urine. It is therefore to some extent a food substance." [2]

Professor Halliburton says: —

"Alcohol is thus within narrow limits a food. . . . It is, moreover, a very uneconomical food; much more nutriment would have been obtained from the barley or grapes from which it was made. The value of alcohol within narrow limits is not as a food, but as a stimulant, not only to digestion, but to the heart and brain." [3]

Professor H. C. Wood says: —

"According to Dupré one gram of alcohol oxidized in the body evolves 7134 units of heat, while the same amount of lean beef gives off only 1482 units of heat. It has been estimated that 9.5 ounces of lean beef, equal to about two ounces of alcohol, will supply the force necessary to maintain the circulation and respiration for one day. That is, four ounces of strong spirit will suffice for this purpose. . . . These considerations warrant the statement that in a certain sense alcohol is a food, i. e., that it is capable of being used for the purposes of the organism." [4]

Landois and Stirling say: —

"Distilled spirits — brandy, whiskey, gin — have but a trifling retarding influence on the digestive processes; and when one considers their action on the secretory glands, it follows that in moderate dietetic doses they promote digestion."

"About 95 per cent. of it [alcohol] is oxidized in the body, chiefly into carbon dioxide and water, so that it is in so far a source of heat. As it undergoes this change very readily, when taken to a certain extent, it may act as a substitute for the consumption of the body, especially when the amount of food is insufficient. (Hammond found that when he lived on an insufficient amount of food, alcohol, if given in certain

[1] M'Kendrick, *Physiology*, Glasgow, 1889, vol. ii. p. 19.

[2] Stewart, *Manual of Physiology*, 1895, p. 414.

[3] Halliburton, *Text-Book of Chemical and Pathological Physiology*, 1891, p. 600.

[4] H. C. Wood, *Therapeutics*, 1901, p. 284.

quantity, supplied the place of the deficiency of food and he even gained in weight. If, however, sufficient food was taken, alcohol was unnecessary.) . . .

"Alcohol in small doses is of great use in conditions of temporary want, and where food is taken insufficient in quantity. When alcohol is taken regularly, more especially in large doses, it affects the nervous system, and undermines the psychical and corporeal faculties, partly by the action of the impurities which it may contain, such as fusel oil, which has a poisonous effect on the nervous system, partly by the direct effects, such as catarrh and inflammation of the digestive organs, which it produces, and lastly, by its effects upon the normal tabolism." [1]

Professor Lusk says: —

"Alcohol in the stomach at first prevents the gelatinization necessary in proteid for peptic digestion, but this difficulty is of no great moment, because the absorption of alcohol is rapid and complete. . . . Alcoholic beverages combining alcohol and flavor promote gastric digestion, but often stimulate the appetite in excess of normal requirement." [2]

Finally we may quote the following passage from König: —

"Alcohol in moderate doses is an important stimulant to digestion, and this explains the strong craving for brandy on the part of the laboring class whose food consists of difficultly digested materials (potatoes, bread, etc.). . . .

"C. A. Gluchinsky has recently investigated the influence of alcohol on digestion and has found that it is greatly slowed as long as alcohol is present in the stomach. Alcohol soon (after from one half hour to an hour) disappears from the stomach, however, and as soon as this occurs, acidity of the stomach increases suddenly up to two to three times the degree of acidity when alcohol has not been taken. Corresponding with this, digestion proceeds more rapidly and is completed in less time, in spite of the initial arrest. Hence a moderate amount of alcohol taken a short time before eating must exert a beneficial influence on digestion." [3]

[1] Landois and Stirling, *Text-Book of Human Physiology*, Lond., 1891, pp. 348, 437.

[2] Lusk, *Am. Text-Book of Physiology*, p. 979.

[3] "Der Alkohol in mässigen Gaben genossen, bildet ein wichtiges Reizmittel für die Verdaungsthätigkeit und nicht ohne Grund tritt bei der arbeitenden Classe, welche sich vorzugsweise mit schwer verdaulicher Nahrung (wie Kartoffel und Brod etc.) ernährt, ein starkes Verlangen nach Brantwein auf. . . .

In concluding this topic we may cite a few more passages from standard authorities, placing side by side with them statements from the "indorsed and approved" public school text-books of physiology. While these books will be treated more fully in the proper place, the following form of presentation may assist in making clear the great lack of coördination between these different departments of our educational system.

STANDARD TEXT-BOOKS.

"It may, perhaps, be said with safety that in small quantities it (alcohol) is beneficial, or at least not injurious, barring the danger of acquiring an alcohol habit, while in large quantities it is directly injurious to various tissues." [1]

"In practice we find that in many persons a small quantity of alcohol improves digestion; and that a meal by its means can be digested which would be wasted." [2]

"In attempting fairly to estimate the action of stimulants, especially of alcohol, one point is of utmost importance to remember. It is this — alcohol is a food! If alcoholic stimulants were mere dis-

"INDORSED AND APPROVED" PHYSIOLOGIES.

"Alcohol is universally ranked among poisons by physiologists, chemists, physicians, toxicologists, and all who have experimented, studied, and written upon the subject, and who, therefore, best understand it." [3]

"Alcohol is not a food or drink. Medical writers, without exception, class alcohol as a poison." [4]

"IS ALCOHOL A FOOD?"

"What do you think about it? (Question to the class.) . . . Do you think your body would grow and keep well and strong if you

"C. A. Gluchinsky hat ebenfals die Wirking des Alkohols auf die Verdauung geprüft und gefunden, dass dieselbe stark gehemmt wird, so lange noch Alkohol im Magen vorhanden ist. Der Alkohol verschwindet indess bald (nach ½–1 Stunde) aus dem Magen und sobald dieses geschehen ist, steigt plötzlich der Säuregrad des Magens auf das 2–3 fache des Säuregrades ohne Alkohol. Dem entsprechend schreitet auch die Verdauung schneller vorwarts und ist, trotz der anfänglich ungünstigen Wirkung, in kürzerer Zeit vollendet. Ein mässiger Alkoholgenuss einige Zeit vor dem Essen muss daher günstig auf die Verdauung einwirken." J. Konig, *Chemie der menschlichen Nahrungs- und Genussmittel*, Berlin, 1889, p. 33.

[1] Howell, *Am. Text-Book*, 1896, p. 298.

[2] Fothergill's *Practitioner's Handbook of Treatment*, 11th ed., London, 1897, p. 34.

[3] Quoted from Youmans in *Blaisdell's*, No. 2, p. 232.

[4] *Eclectic*, No. 3, p. 57.

engagers of static force, early exhaustion would be the rule. But as alcohol is a readily oxidizable form of hydrocarbon, it is also a food as well as a stimulant. In fact it is one of the most easily assimilable forms of food, and very frequently it can be taken and utilized when no other form of food is available. While it is a stimulant, an evoker of force, it also supplies to some extent that force in its readily oxidizable self. The experiments of the late Dr. Anstie and Dr. Dupré have placed beyond all question or honest doubt the fact of the oxidization of alcohol within the organism. If alcohol is oxidized in the body, then alcohol is a true food, or furnisher of force." [1]

"The question of the propriety of the daily use of alcohol by healthy men is at present a very serious one, involving so many moral and politico-moral issues that it cannot be fully discussed here. Suffice it to state as obvious inferences from our present knowledge of the physiological action of alcohol, that the habitual use of moderate amounts of alcohol does not directly and of necessity do harm; that to a certain extent it is capable of replacing ordinary food, so that if it be scanty, or even if it be coarse and not easily digested, alcohol, in some form or other, is of great advantage; that in all cases it should be taken well diluted, so as not to irritate the used it instead of bread and meat? No, indeed . . . We know that alcohol is not a food." [2]

"It is important for you to remember that alcohol is a narcotic poison." [3]

"This alcohol is a liquid poison, a little of it will harm any one who drinks it, and much of it would kill the drinker." [4]

"It must be remembered that in whatever quantity, or wherever alcohol is found, its nature is the same. It is not only a poison, but a narcotic poison." [5]

"ALCOHOL A POISON."

"A poison is any substance whose nature it is, when taken into the body either in small or large quantities, to injure health or destroy life.

"In large doses, in its pure state, or when diluted, as in brandy, whiskey, rum, or gin, alcohol is often fatal to life. Deaths of men, women, and children from poisonous doses of this drug are common.

"In smaller quantities, or in lighter liquors, beer, wine, and cider, when used as a beverage, it injures the health in proportion to the amount taken." [6]

"This alcohol is poisonous. It is its nature, even in small quantities, to harm any one who drinks it. It is capable of ruining the character — as well as the health;

[1] Fothergill, *op. cit.*, p. 254.
[2] *Health Series*, No. 1, p. 30 ff.
[3] *Eclectic Series*, No. 2, p. 31.
[4] *Pathfinder Series*, No. 1, p. 41.
[5] *Authorized Series*, No. 8, p. 58.
[6] *Dulaney's Series*, No. 2, p. 46 ff.

stomach; and that wine or malt liquors are certainly preferable to spirits" (p. 377). . . . "As Lieben also found that this substance exists in the urine of dogs, horses, and lions, and as A. Rajewski obtained it from healthy rabbits, it must be acknowledged that our present knowledge strongly indicates that alcohol is formed and exists in the normal organism."[1]

and if one takes enough it will kill him."[2]

In connection with this last statement of Dr. Wood, and as also bearing upon Schäfer's testimony, we should also cite the following from Hoppe-Syler.[3] "Traces of alcohol are found in human organs, such as the brain, muscles, liver, not only after alcoholic indulgence, but, without this, they seem to be constantly present."

Considerable space in all the public school text-books is devoted to various pathological processes which do not properly belong to the domain of physiology, and hence are rarely touched upon in the standard text-books. Among these obesity and fatty degeneration, especially of the heart, and sclerosis, particularly of the liver, are treated as though alcoholic indulgence were practically the only cause. Landois and Stirling remark (§ 453) that fatty degeneration is apt to occur after severe fevers, or after artificial heating of the tissues, after poisoning with phosphorus and arsenic, and "in drunkards." Schmiedeberg makes the effects of chronic alcohol poisoning to consist chiefly in fatty degeneration and increase of connective tissue. But he concludes the topic by saying, "Moderate amounts of alcohol may be taken daily throughout a whole lifetime without producing these changes in the tissues."[4]

[1] H. C. Wood, *Therapeutics*, 1901, pp. 290, 284.

[2] *Union Series*, No. 2, p. 33.

[3] "Spuren von Alkohol finden sich in den menschlichen Organen, wie Gehirn, Muskeln, Leber, nicht allein nach Alkoholgenuss, sondern sie scheinen auch ohne letzeren stets vorhanden zu sein." Hoppe-Syler, *Handbuch der chemischen Analyse*, Berlin, 1895, p. 40.

[4] "Mässige Mengen von Alkohol können täglich ein ganzes Menschenalter hindurch genossen werden, ohne dass solche Gewebsveränderungen als Folgen auftreten." *Grundriss der Arzneimittellehre*, p. 41.

II. LETTERS FROM PHYSIOLOGISTS.

An important part of the data collected consists in letters obtained from physiologists, both in this country and abroad, giving their views upon this subject. A special effort has been made to secure the opinions of all the physiologists who have taken an active part in the movement to diminish the consumption of alcoholic beverages, and the letters from these authorities here presented contain the strongest arguments which science can furnish in favor of the total abstinence agitation.

A number of these letters, representing all shades of opinion, are presented in Appendix I., and it is therefore necessary at present only to sum up as briefly as possible the general position of physiologists as set forth in this body of correspondence.

At the outset circular letters of inquiry were sent first to all members of the American Physiological Society, seventy-two in number; second, to forty-five physiologists, hygienists, and specialists in allied sciences, holding prominent positions abroad. In this way it was hoped to obtain valuable expert opinions from practically the entire scientific world. Below is a copy of the letter sent to American physiologists. The circular to foreign authorities was similar, except that it gave a brief description of "scientific temperance instruction" as to textbooks and time requirements.

(COPY OF CIRCULAR.)

WORCESTER, MASS., October 1, 1897.

The Committee of Fifty has requested me to gather the testimony of physiologists upon two topics relating to the practical teaching of the physiology of alcohol. Your coöperation is very respectfully solicited

First, as to the facts at our disposal, will you please give a list of the points which you consider sufficiently well established and of essential importance to the education of medical and university students? We wish to learn your own view of the physiological value of alcohol as a food, condiment, stimulant, and medicine: its influence upon the tissues, organs, and upon physiological processes. Please give also a list of the impor-

tant points that you think are not sufficiently well proved to form a part of our teaching material, the points about which there is too much present difference of opinion.

Second. To what extent do you think it wise to introduce alcoholic physiology into elementary public school courses? I refer to the "Scientific Temperance Instruction" promoted by the W. C. T. U., viz., the requirement by law that the subject be given considerable prominence throughout the school course. Have you examined any of the "approved and indorsed" physiologies? If so, what ones? What is your opinion of them? Finally, will you give a list of the arguments which seem most conclusive to yourself either for or against this method of preventing alcoholism?

It is desirable that replies be sent in by October 15, but, if that is not convenient, they may still be of value to the investigation as late as December 1.

Sincerely yours, C. F. HODGE.

Thirty members of the American Physiological Society replied to the circular; nine of this number, however, did not wish to enter the discussion. Of those who expressed definite opinions on the subject, all but one, Ph. A. Levene, a recent accession to the ranks of American physiologists, who should possibly be classed among a small group of foreign scientists whose position will receive attention later, oppose the so-called "scientific temperance instruction" as it is now being promoted in the schools, the strong conviction of a number being that it is resulting in more evil than good.

The following foreign authorities were consulted, the science pursued by each being indicated by abbreviations as follows: —

Physiology	Ph.
Psychiatry	Psych.
Hygiene	Hy.
Pathology	Path.
Pharmacology	Phar.

R. W. Boyce, Path.	London, England.
Sir T. Lauder-Brunton, Phar.	London, "
Sir Michael Foster, Ph.	Cambridge, "
Francis Gotch, Ph.	Oxford, "

W. D. Halliburton, Ph.	London, England.
E. A. Schäfer, Ph.	London, "
C. S. Sherrington, Ph.	Liverpool, "
T. S. Clouston, Psych.	Edinburgh, Scotland.
J. G. M'Kendrick, Ph.	Glasgow, "
Wm. Rutherford, Ph.	Edinburgh "
T. Place, Ph.	Amsterdam, Netherlands.
Sigmund Exner, Ph.	Vienna, Austria.
Richard Freih. v. Krafft-Ebbing, Psych.	Vienna, "
Nandor Klug, Ph.	Budapest, Hungary.
Ferencz Tangl, Ph.	Budapest, "
Vasilij Jakovlevic Danilevskij, Ph. .	Charkow, Russia.
Ivan Michajlovic Dogiel, Ph. . . .	Kasan, "
Nikolaj Jevgenjevic Vvedenskij, Ph.	St. Petersburg, Russia.
Kenji Osawa, Ph.	Tokio, Japan.
Jiro Tsuboi, Hy.	Kyoto, "
Sophus Torup, Ph.	Christiania, Norway.
R. A. A. Tigerstedt, Ph.	Stockholm, Sweden.
Ch. Richet, Ph.	Paris, France.
Luigi Luciani, Ph.	Rome, Italy.
Angelo Mosso, Ph.	Turin, "
Gustave Bunge, Ph.	Basel, Switzerland.
August Forel, Psych.	Zurich, "
Justus Gaule, Ph.	Zurich, "
Hugo Kronecker, Ph.	Bern, "
A. Baer	Berlin, Germany.
Julius Bernstein, Ph.	Halle, "
Adolf Fick, Ph.	Würzburg, "
Ditmar Finkler, Hy.	Bonn, "
Carl Flugge, Hy.	Breslau, "
Karl Fränkel, Hy.	Halle, "
F. L. Goltz, Ph.	Strassburg, "
Rudolph Heidenhain, Ph.	Breslau, "
Victor Hensen, Ph.	Kiel, "
Ludimar Hermann, Ph.	Königsberg, "
Emil Kraepelin, Psych.	Heidelberg, "
J. von Kries, Ph.	Freiburg, "
Willy Kühne, Ph.	Heidelberg, "
Leonard Landois, Ph.	Greifswald, "
Eduard Pflüger, Ph.	Bonn, "
Karl von Voit, Ph.	Munich, "

Of the scientists thus appealed to, only thirteen responded. Of these, five are from Great Britain, and they should be considered somewhat by themselves, as standing for the present position of English physiologists. (See letters by Foster, Clouston, Halliburton, Schäfer, and Lauder-Brunton in Appendix I.) Of the other eight, seven — Baer, Dogiel, Fick, Forel, Gaule, Bunge, Richet — are more or less actively interested in the cause of reform in the use of alcohol. They tend, therefore, to regard the subject from a sociological rather than a physiological point of view, and yet it is interesting to notice that, with the exception of Dr. Baer,[1] a physician in a penitentiary near Berlin, no one of them is willing to indorse the "approved text-books." Even Forel, perhaps the most energetic and brilliant advocate of total abstinence in Europe, who goes so far as to maintain that alcohol *in all doses* is a poison, remarks, in speaking of educational methods: "I think that in America somewhat unwise methods have been adopted."[2]

It must not be supposed that the letters of these seven foreign correspondents represent the opinions of Continental physiologists in general. The letters in Appendix I., and the names appended to the statement prepared by Professor Foster, furnish sufficient proof to the contrary. The method of obtaining information and opinions by means of circular letters is objectionable on account of the varying degrees of interest in the subject felt by the persons addressed. The questions asked in our circular letter cannot be properly answered without devoting some little time to the subject, and the conclusion to be drawn from our attempt to gain information in this way is that those interested in alcohol reform are willing to take the time to answer. Those who are not have other work which they regard of more importance.

In order to gain an expression of expert opinion fuller than that elicited by the above circular letter, the matter was brought before the members of the International Physiological Congress which convened in Cambridge in the summer of 1898. To facilitate the work Professor Foster drew up a moderate state-

[1] Even this solitary advocate of "Scientific Temperance Instruction" writes: "Personally, I do not practice total abstinence."

[2] "Ich glaube dass in Amerika in dieser Beziehung theilweise unrichtige Wege betreten worden sind."

ment concerning the influence of alcohol which he considered to represent the views of physiologists generally. Those who were willing were then asked to sign the statement, either as it stood or with such modifications as each might wish to make. Certain names were obtained by special correspondence after the adjournment of the Congress, and in some instances this correspondence drew forth expressions of opinion which are published in their proper place in Appendix I., together with the letters received in reply to the circular.

Dr. Foster's statement is as follows : —

"The physiological effects of alcohol, taken in diluted form, in small doses, as indicated by the popular phrase 'moderate use of alcohol,' in spite of the continued study of past years, have not as yet been clearly and completely made out. Very much remains to be done, but, thus far, the results of careful experiments show that alcohol, so taken, is oxidized within the body and so supplies energy like common articles of food, and that it is physiologically incorrect to designate it as a poison, that is, a substance which can only do harm and never good to the body. Briefly, none of the exact results hitherto gained can be appealed to as contradicting, from a purely physiological point of view, the conclusions which some persons have drawn from their daily common experience, that alcohol, so used, may be beneficial to their health." [1]

The following is an alphabetical list of the signers of this statement, with the modifications desired by certain individuals given in the foot-notes : —

S. von Basch, Director Lab. of Experimental Pathology, Vienna.
J. Bernstein, Prof. Physiol., Halle.
R. Boehm, Prof. Pharmacology, Leipzig.
Arthur Biedl, Priv. Doc. Exp. Path., Vienna.
T. Lauder-Brunton, Lect. Pharmacology, St. Barth's Hosp., London.[2]
P. J. Dear, M. A., Oxford.
Delzenne, Prof. Agrégé Physiol., Montpelier.

[1] With reference to this statement it should be observed that the last clause was intended as a protest against the absolute condemnation of alcohol by the "approved" text-books, and is not to be regarded as an indication that those signing it believe that the usefulness of alcohol as a beverage has been scientifically demonstrated.

[2] Omitting "and so supplies energy like common articles of food" in the sixth and seventh lines, and inserting "in such doses" between "it" and "as" in the seventh line.

M. Dufour, Prof. Agrégé Physique, Nancy.
Eugene Dupuy, Paris.
C. Eckhard, Prof. Physiol., Giessen.
S. Exner, Prof. Physiol., Vienna.
Ph. W. Engelmann, Prof. Physiol., Berlin.
N. Floresco, Préparateur Physiol., Paris.
M. Foster, Prof. Physiol., Cambridge, England.
M. von Frey, Prof. Physiol., Zürich.
J. Gad, Prof. Physiol., Prague.
Arthur Gamgee, Emer. Prof. Physiol., Owen's Coll., Manchester.
W. H. Gaskell, Lect. Physiol., Cambridge, England.
Fr. Goltz, Prof. Physiol., Strassburg.
P. Grützner, Prof. Physiol., Tübingen.
W. D. Halliburton, Prof. Physiol., King's College, London.
W. J. Hamburger, Prof. Physiol., Ecole de Med. Vet., Utrecht.
V. Hensen, Prof. Physiol., Kiel.
Geo. T. Kemp, Prof. Physiol., Univ. of Illinois.
J. von Kries, Prof. Physiol., Freiburg.
H. Kronecker, Prof. Physiol., Bern.
M. Lambert, Prof. Agrégé Physiol., Nancy.
J. N. Langley, Lect. Histology, Cambridge, England.
L. Landois, Prof. Physiol., Greifswald.
J. Latschenberger, Vienna.
J. P. Langlois, Prof. Agrégé Physiol., Paris.
F. Laulanie, Directeur Ecole Vet., Toulouse.
Frederick S. Lee, Prof. Physiol., New York.
A. B. Macallum, Lect. Physiol., Toronto.
Hans Meyer, Prof. Physiol., Marburg.[1]
N. Mislawski, Prof. Physiol., Kasan, Russia.
K. Mitsukuri, Prof. Zoölogy, Tokyo, Japan.
A. Mosso, Prof. Physiol., Turin.
A. Moussu, Prof. Pathol., Ecole Vet., Alfort.
H. Munk, Prof. Physiol., Berlin.
Otto Nasse, Prof. Physiol. Chem. and Pharmacology, Rostock.
H. Öhrwall, Prof. Physiol., Upsala, Sweden.
D. Noel Paton, Lect. Physiol., Edinburgh, Scotland.
William T. Porter, Prof. Physiol., Harvard Medical School, Boston.
J. M. Purser, Prof. Physiol., Trinity College, Dublin.
E. Waymouth Reid, Prof. Physiol., Dundee.
Sydney Ringer, Prof. Clin. Med. Univ. Coll., London.
A. Rollett, Prof. Physiol., Graz.

[1] Makes sixth line read, "and so can supply energy," omitting "like common articles of food." Omit "poison, that is, a" in eighth line.

Giorgio Rotondi, Assist. Physiol., Genoa.

H. Sahli, Prof. Therap., Bern.[1]

F. M. Sandwith, Prof. Medicine, Cairo.[2]

E. A. Schäfer, Prof. Physiol. Univ. Coll., London.

C. S. Sherrington, Prof. Physiol. Univ. Coll., Liverpool.

L. E. Shore, Lect. Physiol., Cambridge, England.

J. Burdon Sanderson, Prof. Physiol., Oxford.

P. H. Pye-Smith, Lect. Guy's Hospital Medical School, London.

W. H. Thompson, Prof. Physiol., Belfast.

Max Verworn, Prof. Physiol., Jena.

A. D. Waller, Lect. Physiol., St. Mary's Hospital Medical School, London.

G. Weiss, Prof. Agrégé Physique, Paris.

W. H. Wilson, Prof. School of Medicine, Cairo.

N. Zuntz, Prof. Physiol. Landwirtschaftliche Hochschule, Berlin.

Comment on the above list of names is unnecessary.

It is interesting to notice that, with the exception of certain of the writers above mentioned as actively engaged in the temperance movement, none of the physiologists whose letters are presented in Appendix I. desire to be regarded as advocates of total abstinence. This attitude seems to be quite independent of the opinion of the writers as to the nutritive value of alcohol. Most of them consider the fact that the greater part of a moderate dose of alcohol is used up in the body, thus setting free energy in the form of heat, to be conclusive evidence of nutritive value, for this is what happens in the case of such recognized nutriments as sugar, starch, and fat. Others, however, with the extreme caution of true science, maintain that "the oxidation of a substance in the animal body does not determine its injurious or its useful effects" (Kühne), and that "a substance may be consumed by the body and liberate energy and yet be harmful" (v. Voit).[3] Dastre proposes to recognize two groups of heat-producing substances, viz., "biothermogens," including the true nutriments (proteids, fats, and starches) which produce heat in connection with the vital processes of the body, and "pure thermogens," including alcohol, glycerine, and certain organic acids, which simply produce heat

[1] In eighth line omit "poison, that is, a."

[2] Add "with food" after "form" in first line.

[3] It will be noticed that this is the opinion held by Fick, see p. 4.

having no relation to vital processes and destined to be got rid of. The questions thus raised are of considerable theoretical interest and are suggestive of new lines of research, but at the present time it is, to say the least, doubtful whether a distinction between useful and useless heat-production can be maintained. Moreover, the question is of little practical importance, for the same writers who thus doubt the nutritive value of alcohol maintain that light wines and beers are not only harmless but even desirable adjuncts to our diet. Thus Dastre writes: "I believe . . . that alcohol, used in weak and reasonable doses, in good wines, at meal times, is an excellent thing, very agreeable, and that it cannot do harm. 'Bonum vinum lætificat cor hominum.'" Von Voit expresses the opinion that "a moderate use of light alcoholic beverages, as for instance beer, is not injurious to health," and Kühne remarks that "when one sees how many normal, hard-working people arrive at a ripe age, while using stimulants with discretion, among which I include the moderate use of alcohol, one does not find good reasons for total abstinence."

III. INDORSED AND APPROVED PUBLIC SCHOOL TEXT-BOOKS.

Exactly what "scientific temperance instruction" is can be learned from this series of text-books, now twenty-five in number; but these books themselves are the embodiment of a movement for temperance instruction, and it may assist us to their better understanding if we study the movement itself for a moment and attempt to discover its origin and estimate its general character.

Scientific temperance instruction in the United States had its beginning in 1879, when Mrs. Mary H. Hunt presented to the National Convention of the Woman's Christian Temperance Union, held at Indianapolis, Ind., her scheme "for thorough text-book study of Scientific Temperance in public schools as a preventive against intemperance." [1] In response, the convention passed the following resolution: —

"*Resolved*, That this Convention consider the introduction of Scien-

[1] A history of the first decade of the Department of Scientific Temperance instruction in schools and colleges of the Woman's Christian Temperance Union, Boston, Washington Press, 383 Washington Street, 1892, p. 6.

tific Temperance text-books into the regular course of study in our public schools as a most hopeful line of work. We therefore urge the various States here represented to take immediate action to secure this important study taught in the schools of their various localities."

A standing committee, with Mrs. Hunt as chairman, was appointed to "translate this resolution into action." The following year, 1880, the work was reorganized as a "Department of Scientific Temperance Instruction in Schools and Colleges," with Mrs. Hunt as a "National Superintendent" in place of the standing committee. Of this change she writes as follows: [1] —

"Here was a turning point in the early history of this movement where, guided by an unseen Power, we planned 'more wisely than we knew.' This unification, resulting from plans emanating from one source, to which all results are reported, has secured a unity of action, with ability to concentrate at desired points, that has been one great secret of success. A great army with battalions in every State and Territory, regiments and companies in all counties, with pickets at every outpost, and all under the guidance of one head, is what this centralization foreshadowed."

In 1888 this movement was incorporated as a department of the World's Woman's Christian Temperance Union, and Mrs. Hunt assumed the title "National and International Superintendent." [2] The work thus spread to "twenty different countries besides the United States."

In order to ascertain something definite regarding the "approval and indorsement" of the text-books, some letters were interchanged with the Department of Scientific Temperance Instruction, and, while the desired information was not given, we learned one fact of importance, viz., the method of organization of the "Advisory Board" which is supposed to have this matter in charge. The letter (April 13, 1897) states: "The names of the board of educators, reformers, physicians, and clergymen associated with Mrs. Hunt in this work were suggested by Mrs. Hunt and elected by vote of the Woman's Christian Temperance Union."

We call attention to these things to make clear two points: First, the purely autocratic character of the movement. For

[1] *Loc. cit.*, p. 7. [2] *Loc. cit.*, p. 101.

its origination, for its policy, and for every development in its history, Mrs. Hunt is practically responsible.

Second. That it was founded, from its very beginning, on the text-book theory of instruction, and has therefore had behind it the powerful influence of the text-book publishing firms throughout the country.

The true character of the movement is well set forth in one of the publications of the Woman's Christian Temperance Union.

> "This is not a physiological, but a temperance movement. In all grades below the high school this instruction should contain only physiology enough to make the hygiene of temperance and other laws of health intelligible. Temperance should be the chief and not the subordinate topic and should occupy at least one fourth the space in text-books for these grades." [1]

The above platform expresses in few words the animus of the whole movement. It is frankly and honestly the total abstinence reform, a movement in this country often connected with partisan politics and with some denominations associated with religious work. As is generally the case when feeling and prejudice run high, the temptation has been irresistible to either manufacture evidence or stretch it over points that it does not cover; to call "scientific" everything that happens to agree with particular prejudices, and to relegate to the limbo of human error all the evidence that appears for the other side. Another characteristic feature of this movement has been the flattery of authors who favor the views to be inculcated with such appellations as "greatest living authority," "foremost scientist," "the wise physician of to-day, who is abreast of the modern investigations concerning this drug," "author of great prominence," "most skilled in his profession," "eminent scholar," etc. These phrases are rarely, if ever, applied to persons who are recognized by men of science as authorities on this question.

To give effect to this policy of compulsory "scientific temperance education," laws have been enacted in nearly all the States of the Union. This has usually been effected without much opposition, the excellence of the motive tending to disarm criticism. The present New York law, however, which is one

[1] *Science Temperance Monthly Advices*, March, 1892, p. 4.

of the most stringent that has ever been enacted, was placed upon the statute books in spite of the organized and strenuous opposition of the teachers of the State who were in entire sympathy with the general principle of temperance instruction and who had done excellent work under the more reasonable law of 1884.

The laws of the different States, most of which will be found in Appendix II., differ greatly as to their provisions. In their simplest form "Physiology and hygiene, which in both divisions of the subject shall include special instruction as to the effects of alcoholic drinks, stimulants, and narcotics on the human system" (Massachusetts law), are placed on the list of prescribed studies. Such laws have been obviously found insufficient to force the "approved and indorsed" text-books upon the public. Accordingly a text-book clause has been frequently added, compelling the use of text-books which contain a definite proportion, usually one fourth or one fifth, for graded schools, and twenty pages of temperance matter in books intended for high school use. A definite number of lessons, generally three lessons per week for fourteen weeks each year from the primary to second year in the high school, has also been made compulsory, and further, penal clauses, removal from office (District of Columbia law), or fines (New York law), have been incorporated into a number of the statutes. The bill presented during the winter of 1898–99 to the Massachusetts legislature may be taken to represent the latest effort of the department of "scientific temperance education," and a brief account of the discussion to which it led may therefore be introduced in this connection.

This bill[1] (see Appendix II.) defined more accurately than the existing law the amount of time to be devoted to temperance teaching and provided a penalty in case of failure on the part of school committees to conform to the law.

The committee on legislation of the Massachusetts Medical Society, acting under instructions from the society, appeared in opposition and presented a bill[2] providing for instruction in the action of stimulants and narcotics to such classes and in such manner as school committees may determine (see Appen-

[1] Known as the "Morgan-Hunt Bill," Senate, 41.

[2] Known as the "Myers Bill," House, 817.

dix II.). In behalf of the former bill appeared three members of the "Massachusetts Central Committee for the Promotion of Scientific Temperance Instruction in the Public Schools," who introduced evidence which "may be roughly classified as follows: —

"1. Dissertations on the evils of intemperance.

"2. Certifications of Mrs. Hunt's uprightness of character and nobility of intentions coupled with broad insinuations that those who oppose her bills are in league with the liquor interests.

"3. Statements in regard to the beneficent effects of similar laws in other States as proved by a decrease in the consumption of beer and the good health of the troops during the late war." [1]

Evidence belonging to the first and second classes required, of course, no answer: that of the third class was easily shown in the hearing before the legislative committee to be entirely misleading.

The latter bill was supported —

1. By a committee of the Massachusetts Medical Society, who presented the result of a canvass of school superintendents and teachers showing an overwhelming preponderance of opinion in favor of the bill and abundant evidence of the failure of the present law to accomplish the desired results.[2]

2. By the Secretary of the State Board of Education, who testified to the efforts of the "scientific temperance" people to secure the dismissal of state employees suspected of not being sufficiently in sympathy with their own extreme views.

3. By the most prominent educators, physicians, and clergymen of the community, some of whom had favored "scientific temperance" legislation in 1885.

The fact that in a State like Massachusetts educators generally united against more strenuous legislation and in favor of a less exacting measure is of great significance. After fourteen years' experience, the solid front of opposition presented by Massachusetts teachers and educators was decisive proof that legislation in this direction had gone too far. The reasons for this opposition must be sought wholly in the methods rather than in the object of this "scientific temperance" propaganda.

[1] Dr. G. W. Fitz, letter in *Boston Transcript*, March 31, 1899.

[2] For a fuller presentation of this evidence, see pp. 38–44.

Among these reasons, the character of the approved text-books is probably the most important, as these books embody the arbitrary and unpedagogical character of the movement.

Dr. Fitz thus briefly states the case: —

"The points of opposition can be summed up as follows: (1) The specification by law of the amount of physiology and hygiene to be taught in the schools and of the time to be devoted to it, a specification not made for any other subject; (2) the impossibility, from scientific and pedagogic considerations, of teaching physiology and pathology to children; (3) the irrationality of the idea that a frequent repetition of exaggerated statements develops character; (4) the danger of familiarizing the children of Massachusetts, who in the large majority of cases have temperate homes, with the methods and effects of evil conduct; (5) the preposterousness of the attempt to force teachers and school committees to act contrary to their convictions; (6) the failure of the supporters of the Morgan-Hunt bill to consult the teachers or to study the school conditions in a way which would make it possible for them to devise rational methods of instruction."

After prolonged hearings, the Committee on Education gave the petitioners for the former bill "leave to withdraw" and reported that the latter bill "ought not to pass," thus leaving the existing law in force.

Approved and indorsed public school text-books are commonly published in series of three or four, adapted, supposedly, for primary, intermediate grammar, grammar, and high school use. The following list [1] gives the books in each series with publishers. It will be noted that there are in all twenty-three different books, representing seven different publishing firms. Excepting for the present, Dr. Martin's text-book, which will receive special attention later, they may all be treated together, since they are all constructed on the same lines. While this is essentially true, it should be specially noted that eight of the remaining twenty-two books are published anonymously. These are, Authorized Series, No. 1; Dulaney's Series, Nos. 1 and 2; Pathfinder Series, Nos. 1 and 2; and Union Series, Nos. 1, 2, and 3. None of these books are vouched for by any authoritative writer's name. Still they have received unqualified "indorsement" of the Department of "Scientific Temperance In-

[1] See p. 29.

struction." For example, in the indorsement of the Pathfinder Series we are informed: —

"The above are the series originally prepared (as their general title indicates) to supply the demand created by the laws for temperance instruction in public schools in the United States. They were written by experts under the supervision of the Scientific Department of the National Woman's Christian Temperance Union, published by the instigation of the same, and have been carefully revised from time to time, under the same supervision, to keep them abreast with the latest teachings of science.

"Being both teachable and well adapted to grade, their educational value, as proven by school-room tests, is of the highest order. We therefore cordially indorse and highly recommend the Pathfinder Series for use in schools.

MARY H. HUNT,

National and International Superintendent of the Scientific Department of the Woman's Christian Temperance Union; Life Director of the National Educational Association.

ADVISORY BOARD. Joseph Cook, William E. Sheldon, Albert H. Plumb, D. D., Daniel Dorchester, D. D."

An indorsement of this general character is printed upon the back of the title-page of text-books approved by the W. C. T. U., and so extensive and so well organized are its branches throughout the United States, and so effectively is the work of regulating the character of the text-books done, that publishers have found it difficult at times to sell text-books which have not this mark of official approval or which, at any rate, do not teach doctrines in conformity with those of the organization referred to.

How far this supervision keeps the text-books "abreast with the latest teachings of science" a single example will suffice to show. Steele's "Hygienic Physiology" (No. 3 of the Pathfinder Series) contains on pp. 177–179 a clear statement of the doctrine that alcohol is eliminated entirely unchanged. The several successive editions of this book contain the above-quoted indorsement dated, in the last edition, June, 1889. Now the weight of scientific evidence in favor of the oxidation of alcohol in the body is, as elsewhere set forth, absolutely overwhelming. Even Dr. Benjamin W. Richardson, of London (than whom no writer on the effects of alcohol is more often quoted in temper-

ance publications), in one of his well known Cantor lectures on Alcohol,[1] delivered in 1874, declares that "while it is true that, under certain circumstances, alcohol taken into the body will pass off in the secretions unchanged, the quantity so eliminated is the merest fraction of what has been injected."

In other words, fourteen years after Sir Benjamin Richardson had taken pains to show that this doctrine which the text-book teaches is utterly untrue, the indorsement signed by Mrs. Hunt as superintendent and by four persons as members of the Advisory Board of the Scientific Department of the W. C. T. U. stated that the book had been revised to keep it abreast with the latest teachings of science, and this indorsement has remained in the editions up to the present time.

In 1895 the attention of the Department of Scientific Temperance Instruction of the W. C. T. U. was called to this and other errors in this specific book as types of errors in the indorsed books generally. The only reply was a circular published a year and a half later purporting to be prepared at the instance of Christian churches and allied philanthropic organizations, and stating that this and twenty other "approved" or "indorsed" physiologies had been carefully examined by a committee of "eminent medical experts," "occupying the very first rank in their profession," and that "after minute and careful examination" "not a single member" "reports finding them inaccurate, but exactly the reverse."

With regard to these "eminent medical experts" it may perhaps be proper to remark that their names would not be likely to suggest themselves to physiologists as those of authorities in this particular subject, though some of them are eminent in other departments of medicine.

[1] Lecture IV. On the Position of Alcohol as Food. See pages 107–111 of *Ten Lectures on Alcohol*, by Benjamin W. Richardson, M. A., M. D., F. R. S., National Temperance Society and Publication House, New York, 1880.

LIST OF BOOKS EXAMINED, WITH THE ABBREVIATIONS WHICH WILL BE USED IN REFERRING TO THEM.

	ABBREVIATION.	
Authorized Physiology Series. American Book Company.		
No. 1. Health for Little Folks. Anonymous.	Authorized Series,	No. 1
No. 2. The Human Body and How to Take Care of It, by James Johonnot and Eugene Bouton, Ph. D.	" "	No. 2
No. 3. Anatomy, Physiology and Hygiene. R. S. Tracy, M. D.	" "	No. 3
Brands' Physiology, Hygiene, Narcotics. Leach, Shewell & Sanborn.		
Good Health for Children (Primary). Orestes M. Brands.	Brands,	No. 1
Health Lessons for Beginners. Same author	"	No. 2
Blaisdell Series. Ginn & Co., 1896 and 1897.		
The Child's Book of Health. Albert F. Blaisdell, M. D.	Blaisdell,	No. 1
How to Keep Well. Albert F. Blaisdell, M. D.	"	No. 2
Our Bodies and How We Live. Same author.	"	No. 3
Dulaney's Series. Wm. J. C. Dulaney Co., Baltimore.		
Dulaney's Primer of Physiology. Anonymous.	Dulaney's,	No. 1
Dulaney's Physiology. Anonymous.	"	No. 2
Eclectic Educational Series. American Book Company.		
The House I Live in. Eli F. Brown, M. D.	Eclectic,	No. 1
Youth's Temperance Manual. Eli F. Brown, M. D.	"	No. 2
The Eclectic Guide to Health. Eli F. Brown, M. D.	"	No. 3
Stowell's Health Series. Silver, Burdett & Co., 1896.		
A Primer of Health. Charles H. Stowell, M. D.	Health Series,	No. 1
A Healthy Body. Charles H. Stowell, M. D.	" "	No. 2
The Essentials of Health. A Text-book on Anatomy, Physiology, Hygiene, Alcohol, and Narcotics.	" "	No. 3
Pathfinder Series. American Book Co.		
Child's Health Primer. Anonymous.	Pathfinder Series,	No. 1
Young People's Physiology. Anonymous.	" "	No. 2

Lessons in Hygiene. Anonymous.	Pathfinder Series,	No. 3
Hygienic Physiology, by Joel D. Steele, Ph. D.	" "	No. 4
The Union Series. E. H. Butler & Co., Phila.		
Physiology and Health, No. 1. Anonymous.	Union Series,	No. 1
Physiology and Health, No. 2. Anonymous.	" "	No. 2
Physiology and Health, No. 3. Anonymous.	" "	No. 3
The Human Body and the Effects of Narcotics. Martin.	H. Holt & Co.	

Quotations have already been given from a number of the approved books. A list of similar citations has been prepared containing one or more from each book. Since they are all so much alike, however, we shall now present only one quotation from each series, selecting these under the main topic of the food value of alcohol.

"*Alcohol a Poison.* — The nature of alcohol is that of a poison. . . . It has often been urged that men have been known to drink alcoholic liquors for a long time and yet live. A great English physician said concerning this, 'The stomach and other organs of the body may be so hardened and changed by alcohol that it may seem to fit them for a long time, but the alcohol will all the while be doing its fatal work.'" [1]

"*Alcohol as a Poison.* — Any substance capable, when absorbed into the blood, of injuring health or destroying life, is a POISON. Alcohol is capable of destroying life when taken in sufficient quantities, as has been proved by numerous instances of death following the drinking of spirits on a wager, or a draught of brandy or gin taken in ignorance by a child. Remember this — ALCOHOL IS A POISON." [2]

"*Alcohol a Poison.* — A cat or dog may be killed by causing it to drink a small quantity of alcohol. A boy once drank whiskey from a flask he had found, and died within a few hours. His death was caused by the alcohol in the whiskey. Many people have been poisoned by liquor containing alcohol. . . . It is in the nature of alcohol to make drunkards." [3]

"Any drink that contains alcohol is not a food to make one strong; but is a poison to hurt, and at last to kill." (A category of crimes follows.) "You may say that all men who drink liquor do not do such terrible things. That is true. A little alcohol is not so bad as a great deal. But even a little makes the head ache and hurts the brain and nerves. . . . A man who never drinks liquor will get well where a drinking man would surely die." [4]

[1] Authorized Series, No. 2, p. 35–37.
[2] Blaisdell, No. 3, pp. 84 ff.
[3] Brands, No. 1, 19 ff. and 27.
[4] Dulaney's, No. 1, p. 33 ff.

"Alcohol is a colorless liquid poison. Its presence makes what was before good fruit juice a poisonous liquid" (p. 27). "We now know that fermentation changes entirely the nature of the substance upon which it acts. In this case it changes a food to a poison. To attempt to drink fermented liquors moderately has led to the hopeless ruin of untold thousands." [1]

"We can find nothing about it [alcohol] that gives us any idea that it is a food. . . . Alcohol is not in any sense a food." [2]

"It is not a food. We have shown that alcohol and all spirituous liquors are poisonous. For this reason alone we should not expect to find them valuable for food. . . . Then again, close observation of its effects on man does not warrant us in believing that it has any value whatever as a food." [3]

"Alcohol is not a food, for it cannot build up any part of the body. It contains no mineral substance and will not make healthy fat." [4]

"*Alcohol not a Food.* — You have learned that food supports life. Alcohol will not nourish or build up the body or any of its parts; it is its nature to injure health and destroy life. Alcohol is not a food." [5]

The above may serve to demonstrate the character of these books as well as hundreds of similar passages which could be given. When these are compared with the standard authorities already referred to, it is clear how great is the disadjustment between this public school education and that in our colleges, universities, and medical schools. Moreover, school-children now have ready access to libraries, and there they may easily find statements which modify and even directly contradict the most emphatic statement of their books. It is little wonder that educators and teachers oppose "scientific" temperance. It is no part of our present purpose to discuss the truth or falsity of these statements. We are endeavoring solely to present the teaching of alcohol physiology as it actually exists. Until scientific investigation is able to furnish more definite and uniform data, it would seem self-evident that compulsory education, especially in the form of text-book memorizing, could result in nothing but the widespread demoralization of our youth. They can hardly escape the conviction that an attempt is being deliberately made to deceive them for a special, supposedly moral, purpose.

[1] Eclectic Series, No. 1, pp. 27, 28.
[2] Health Series, pp. 74, 75.
[3] Health Series, No. 3, p. 55.
[4] Pathfinder Series, No. 1, p. 14.
[5] Union Series, No. 2, p. 67.

The argument constantly advanced to excuse this lack of adjustment is that elementary physiology should not touch upon medical uses of alcohol. This is emphatically stated in the published "Standard for Temperance Physiologies," as follows: —

"This effort to disabuse the minds of the rising generation of the fallacies which lead to drink habits should purposely avoid reference to the medical use of alcohol. As by common consent its lay prescription is condemned, the question of its use as a remedy may properly be relegated to medical treatises, as out of place and misleading in a school text-book."

But it must be generally admitted that there cannot be one truth for elementary schools, and truth exactly contradicting it for colleges and medical schools. There is but one science of physiology. And, furthermore, the use of alcoholic drinks has passed almost as completely beyond the control of the medical profession as has that of other common articles of diet.

The statements already quoted, and we shall add a few more, seem to indicate that the text-books are written with a deliberate purpose to frighten the children, the younger the better, so thoroughly that they will avoid all contact with alcohol, an attempt fraught with danger on account of the natural reaction of healthy children, boys especially, to such exaggerated statements. On no other theory, it would seem, can such statements as the following be explained: —

"Alcohol sometimes causes the coats of the blood vessels to grow thin. They are then liable at any time to cause death by bursting." [1]

"Worse than all, when alcohol is constantly used, it may slowly change the muscles of the heart into fat. Such a heart cannot be so strong as if it were all muscle. It is sometimes so soft that a finger could easily be pushed through its walls. You can think what would happen if it is made to work a little harder than usual. It is liable to stretch and stop beating and this would cause sudden death." [2]

"Many people are made crazy by the use of alcoholic liquors. In some asylums where these people are kept, it has been found that nearly one half of the crazy people were made crazy from this cause. Not all of these were drinkers themselves. It often happens that the

[1] Authorized Series, No. 1, p. 61.

[2] Brands, No. 1, *Good Health for Children*, p. 69.

children of those who drink have weak minds or become crazy as they grow older." [1]

"Do you remember what we said about beer making some people fleshy? We said that the muscles became soft and filled with fat. Because the heart is a muscle, it, too, may become fatty from drinking beer. This makes it larger and at the same time softer and weaker. Physicians call this disease 'the fatty heart' because there is so much fat in the muscles of the heart. At last the heart becomes so weak it cannot do its work, and suddenly death occurs. From this we learn that some alcoholic drinks may cause a disease of the heart which no physician can cure, and which may result in sudden death." [2]

"Sometimes the stomach is so hurt by alcohol that the drinker dies." [3]

"There is one form of this disease, called alcoholic consumption, which is caused by alcohol. The drinker looks well, till suddenly comes a 'dropped stitch,' or a pain in the side. Then follows difficulty of breathing and vomiting of blood, then a rapid passage to the grave; for medicine, food, change of air, all prove useless." [4]

"A noted murderer confessed that never, but once, did he feel any remorse. Then he was about to kill a babe, and the little creature looked up into his face and smiled.

"'But,' he said, 'I drank a large glass of brandy, and then I did n't care.'" [5]

These are but a few citations among many that might be given. The books, especially those intended for the lower grades, fairly bristle with statements of a character to work upon the fears of the reader, and remind one in this respect of patent medicine advertisements.

"Such a treatise as the New York law contemplates cannot be written by a scientific man." [6] This remark by Dr. Jordan applies to the whole machinery of scientific temperance text-book making. Speaking of those who are connected with the approval and indorsement of the text-books, he continues: —

"Indeed, they have the effrontery to demand of a scientific author in treating a certain scientific subject in the school courses that he

[1] *Idem.* No. 1, p. 44. [2] Health Series, No. 1, pp. 47, 48.

[3] Dulaney's, No. 1, p. 88.

[4] Dulaney's, No. 2, p. 123; Pathfinder, No. 2, p. 91.

[5] Dulaney's, No. 2, p. 186; Pathfinder Series, No. 2, p. 179.

[6] *Popular Science Monthly*, 1896, p. 351.

shall introduce only so much of the subject as shall bear on a certain reform that they are advocating. Can even earnestness of purpose or the importance of the reform be a shadow of an excuse for such a course?"

In this connection it may be interesting to quote the remark of the author of an approved series of text-books to a member of this committee: "I have studied physiology," said he, "and I do not wish you to suppose that I have fallen so low as to *believe* all of the things I have to put into those books." That he had fallen low enough to put them in without believing them did not seem to disturb his mind.

Among the writers of the text-books which we are considering, Professor H. N. Martin is perhaps the only one who can be properly regarded as a professional physiologist of high standing, and it is therefore interesting to compare the statements with regard to alcohol in his text-book for medical students with those which he puts forth when he is writing to satisfy the requirements of the Woman's Christian Temperance Union. These statements are here presented in parallel columns.

MARTIN.

HUMAN BODY, ELEMENTARY.[1]

"Has alcohol a just claim to be called a food? Is alcohol a tissue-forming food? To this the answer is certainly, No; so far at least as useful tissue is concerned (since it contains no nitrogen, etc.).

"Is alcohol a strengthening food? To this the answer is, No. Does alcohol keep up the heat of the body? To this question, also, the answer is No, though this may seem a strange view of the fact that a drink is often taken to 'warm one up.'"

Dr. Martin evades asking or attempting to answer the clear physiological question, Is alcohol

HUMAN BODY, ADVANCED COURSE.

"ALCOHOL. There are perhaps no common articles of diet concerning which more contradictory statements have been made than alcoholic drink. This depends upon their peculiar position: according to circumstances, alcohol may be a poison or be useful; when useful it may be regarded either as a force regulator or as a force generator. It is sometimes a valuable medicine, but it does no good to the healthy body. If not more than two ounces (which would be contained in about four ounces of whiskey or two quarts of lager beer) are taken in the twenty-four hours, they are completely oxi-

[1] Indorsed and approved.

capable of yielding energy to the body (as do carbohydrates and fats)? and is enabled to conclude: —

"The study of alcohol as an article of diet leads therefore to the result that it cannot fairly be regarded as a food." [1]

dized in the body and excreted as water and carbon dioxide. In this oxidation energy is of course liberated and can be utilized. . . . If the facts lead us to conclude, against the extremists, that it is to a certain extent a food, it is nevertheless a dangerous one; even in what we may call 'physiological' quantities, or such amounts as can be oxidized in the body." [2]

We feel obliged in this connection to call attention to the manner in which scientific authorities are misquoted in order to appear to furnish support to "scientific temperance instruction." In the "School Physiology Journal," Mary H. Hunt, editor, November, 1897, an editorial occurs entitled "The Findings of Science." It reads in part as follows: —

"During the past two years two important papers containing original investigations upon the effects of alcohol have been published in this country. In each case 'the writer had previously doubted the universal poisonous action of alcohol, and had openly expressed a strong belief in its food and stimulative value' (from what authority this is quoted, we are unable to state). As results of these investigations, however, Dr. Chittenden of Yale University finds that 'amounts of alcohol equal to five per cent. are markedly injurious and retard digestion,' and Professor Hodge of Clark University arrives at the conclusion that 'alcohol always lowers working power, and, in some degree, interferes with growth.'"

The paper first referred to is evidently Chittenden and Mendel's "Influence of Alcohol and Alcoholic Drinks upon the Chemical Processes of Digestion." We have not succeeded in finding the words purporting to be quoted from Chittenden, and they evidently completely misrepresent his position. The statement is, in fact, contradictory to his conclusion (pp. 10 and 81): "First, it is plainly manifest that in the presence of small amounts of alcohol (one half of one per cent. of absolute alcohol) gastric digestion may proceed as well, or even better,

[1] Martin, *The Human Body. An Elementary Text-Book*, etc., N. Y., 1894, pp. 141 ff.

[2] Martin, *The Human Body*, N. Y., 1890, pp. 304, 305.

than under normal circumstances." And on page 82, speaking of salivary digestion, he says: "With active saliva not greatly diluted, the presence of even five per cent. of absolute alcohol may lead to a slight increase of digestive power." In his concluding paragraph he again cautions against drawing any such sweeping conclusions as that intimated in the "School Physiology Journal," as follows: "The results recorded do not afford data for drawing any broad or general conclusions regarding the influence of alcoholic drinks upon digestion or alimentation, since they throw no light upon possible modifications of secretion, absorption, or peristalsis."

With reference to the second purported quotation, Dr. Hodge is able to deny that it occurs in any of his published writings, or elsewhere, so far as he knows. He has certainly not drawn any such sweeping conclusion from his own experiments.

Another illustration of the way in which the method of partial quotation of scientific authorities is employed to serve the purposes of the Woman's Christian Temperance Union is furnished by the use made of Liebig's statement as to the nutritive value of beer often quoted in the school physiology journals and similar publications. It reads as follows: —

"We can prove with mathematical certainty that as much flour as can lie on the point of a table knife is more nutritious than eight quarts of the best Bavarian beer."

This statement occurs in a rare edition of Liebig's "Chemical Letters," published in 1852, and in no previous or subsequent editions. It is well known that Liebig divided all food substances into two groups, viz., nitrogenous or plastic foods and non-nitrogenous or respiratory foods. While we have not been able to see the edition in which this statement occurs, it is evident from what we have learned of it and from statements in the same connection in other editions, that Liebig, in making this statement, must have had in mind the *nitrogenous* ingredients of beer. To this group he attached the greater physiological importance, believing them to be the sole source of mechanical energy of the body, while the latter group served for the production of animal heat. This distinction cannot be maintained in the light of later investigations. That Liebig

clearly had it in mind, however, in writing the above paragraph, is shown by the fact that he elsewhere mentions specifically alcohol, beer, and wine as "respiratory foods." It is, therefore, evident that to make the above statement accurately express Liebig's view, it should be altered so as to read, "contains more nitrogenous nutriment than eight quarts," etc. Taken by itself, it entirely misrepresents Liebig's position.

R. O. Neumann calls attention to the above quotation from Liebig in an article on the "Significance of Alcohol as Food" in the "Archiv für Hygiene," 1899, vol. xxxvi, pp. 2, 3. He gives the quotation in more detail as follows: —

> "As much flour as can be held on the point of a knife-blade is more nutritious than five (Bavarian) quarts of the best Bavarian beer. A man who should be in condition to drink daily five quarts of beer would thus have in a year, under favorable circumstances, exactly as much nutritive material as in a five-pound loaf of bread or in three pounds of meat."

A calculation based on the combustion warmth of starch leads Neumann to the conclusion that, in this estimate of the nutritive value of beer, Liebig has committed an error of over 8000 per cent.

He notes, however, that, seven years later, Liebig, as the results of his experiments in metabolism, reached the conclusion that alcohol, in its value as a respiratory food, stands nearest to the fats.

IV. ANSWERS OF PUBLIC SCHOOL-TEACHERS.

Teachers possess a vantage ground in opportunities for observation and experience in educational matters held by no other class of the community. Certainly one of the weakest features of the present plan of instruction in so-called scientific temperance has consisted in almost total failure to adequately recognize this fact. And it is safe to say that ultimately the form which this instruction shall take must of necessity be determined by the tact and wisdom of our teachers. It is also safe to predict that in so difficult and delicate a subject there must be the greatest possible freedom of method. Each teacher must be allowed to work in his own way and adapt his teaching to needs of different classes of pupils and

even to different individuals, if the greatest good and the least harm is to result.

Four investigations have been made as to methods and results of scientific temperance instruction in the schools. Each was made independently of the others, by different methods, and from differing points of view. The fact that they all converge upon much the same general result is significant.

The first investigation was made by George H. Martin, Agent of the Massachusetts State Board of Education, by actually examining schools in which this instruction had been given.[1] Of the answers given by the pupils to his questions he publishes a sufficient number to demonstrate the futility of present methods. Since yearly repetition is so prominent a feature in the present plans of study, possibly the most suggestive result is that whether one year or six years are devoted to text-book work on the subject makes practically no difference with the amount of a pupil's knowledge. He says on this point: —

"Pausing to consider the schools where text-books are used for a longer or shorter time, the character of the papers presented seems to depend more on the general character of the school and the ability of the pupil than on the number of years spent in the study of alcohol.

"If we select a number of schools in which the subject is studied from text-books one, two, three, or more years, we shall find the best papers presented will cover essentially the same facts in all the schools. On the other hand, the average papers, after one year's use of the book, may be better than other schools will furnish after five or six years' study."

Mr. Martin draws the following conclusions, which we quote in full: —

"1. The phrase 'scientific temperance instruction' sometimes applied to this work is a misnomer. There is, and in the nature of things can be, no such instruction. The two essential elements of scientific study — observation and inference — are necessarily wanting; neither the pupil nor the teacher can have first-hand information.

"2. That the outcome in accurate knowledge resulting from much of the work done is meagre and out of proportion to the time spent upon it.

[1] George H. Martin, "Physiology and Hygiene," *Massachusetts State Board of Education, Fifty-fifth Annual Report*, 1890–91, pp. 312–326.

"3. That many false impressions are left in the minds of the students.

"4. That physiological details are not suited to young children.

"5. That however defective the instruction may be, the sentiment of the school is sound, — the conviction that alcohol and tobacco are bad things to use seems universal.

"6. That the strength of this sentiment does not depend upon the amount of information acquired.

"7. That where exaggerated notions of the effects of stimulants have been acquired, there is danger of a reaction of sentiment in the light of after-knowledge."

Mr. Martin also offers the following suggestions: —

"1. That committees and superintendents give more careful attention to work in this department, prescribing definitely its limits, and requiring the prescribed work to be done as well as work in other subjects, using the same means for judging its progress and results.

2. That teachers who are called upon to give oral instruction prepare themselves with great care for the exercise, and see that their statements are true, and by frequent tests, oral and written, ascertain that their teaching is intelligently comprehended by all the pupils.

"3. That, when no text-book is used in any grade, the teachers prepare for the highest classes a summary of the effects of stimulants and narcotics upon the different systems of the body, aiming at clearness of statement and avoiding exaggeration.

"4. That the use of text-books be limited to the older pupils.

"5. That so much of explanation accompany the use of the book as may be necessary to guard against error, and insure exact knowledge.

"6. That, as far as possible, technicalities be avoided.

"7. That the pupils have frequent opportunity to express their knowledge orally and in writing.

"8. That throughout the course the moral and social effects of the use of intoxicants be made prominent, and abstinence be inculcated from higher grounds than such as concern only the body."

Dr. G. W. Fitz next investigated the condition of "scientific temperance instruction" in Massachusetts with a view to ascertain what difficulties attached to the present plan and what changes in legislation might be acceptable to teachers. Letters of inquiry were sent to superintendents and principals throughout the State. Eighty-three (83) cities and towns were thus heard from. These represented 113,000 children and about 4000 teachers. These figures cover more than one quarter of

the total number of children (409,000), and of teachers (12,-000), in the State.

Replies to some of these questions Dr. Fitz has tabulated as follows: —

What are the results of this (temperance) instruction?

Excellent, if well taught	2	per cent.
Good	11	"
Medium	15	"
Little	14	"
None	55	"
Bad	3	"

This gives 28 per cent. who think the results are excellent, medium, or good, and 72 per cent. who consider them little, none, or bad.

To the question "What value has the instruction in mental and moral discipline?" the answers are: —

Great	1	per cent.
Good	16	"
As much as other subjects	24	"
Little	31	"
None	28	"

A somewhat larger percentage are thus seen to look with some favor upon the disciplinary value of this instruction, and still a considerable majority, 59 per cent., consider it to possess little or none.

A continuation of Dr. Fitz's investigation consisted in gathering (1898–99) the votes of 2884 Massachusetts teachers upon the question whether it was desirable to have more stringent legislation (represented in the Morgan-Hunt bill, Senate, 41) or less exacting laws (as embodied in the Myers bill, House, 817). Copies of both bills were distributed with all the letters of inquiry, and are to be found in Appendix II. The result of this canvass, with the issue very definitely stated, showed 98.2 per cent. of the teachers in favor of the Myers bill. Only 1.8 per cent. favored the Morgan-Hunt bill. A modification of these bills rendered a second canvass necessary, but the opinion of the teachers on the bills in the new form remained unchanged.[1]

[1] For the nature of these modifications, see letter of Dr. G. W. Fitz, Secretary of the Massachusetts Medical Society Committee, inclosing Mrs. Hunt's modified bill, Appendix II., p. 134.

A third investigation was undertaken by Mr. Walter A. Wyckoff and the result presented to the Committee of Fifty by Professor Sloane. In this case an attempt was made to obtain the expert opinion of representative teachers in forty-eight States and Territories and in the District of Columbia. As a report upon this investigation will naturally form a part of the report of the Ethical Committee, it will be sufficient to say in this connection that the results agree with those above presented in finding overwhelming majorities of the teachers opposed to exacting legislation upon this subject, while practically all are agreed that the subject ought to receive a reasonable amount of attention in connection with courses in physiology and hygiene.

Our own study of the subject consisted in distributing 500 slips containing the questions given below among teachers. About 200 each were distributed in New York and Massachusetts and 100 in Wisconsin. New York has the very exacting Ainsworth law, while Wisconsin and Massachusetts have moderate laws, though in Massachusetts it has been very strictly interpreted.

The following is a tabulation of the questions with all the answers received.

Do you approve the teaching of alcohol physiology as promoted by the department of scientific temperance instruction of the Woman's Christian Temperance Union?

Mass.: Yes, 26.	N. Y.: Yes, 16.	Wis.: Yes, 12.	Totals: Yes, 54.
Mass.: No, 56.	N. Y.: No, 45.	Wis.: No, 18.	Totals: No, 119.

Do you favor such instruction being made compulsory by state law?

Mass.: Yes, 24.	N. Y.: Yes, 22.	Wis.: Yes, 11.	Totals: Yes, 57.
Mass.: No, 42.	N. Y.: No, 43.	Wis.: No, 19.	Totals: No, 104.

What do you think of the "approved and indorsed" school physiologies?

Mass.: Good, 19.	N. Y.: Good, 15.	Wis.: Good, 13.	Total: Good, 47.
Mass.: Bad, 28.	N. Y.: Bad, 40.	Wis.: Bad, 18.	Total: Bad, 86.

In your opinion, are results of the instruction now given good or bad?

Mass.: Good, 19.	N. Y.: Good, 25.	Wis.: Good, 15.	Total: Good, 59.
Mass.: Bad, 34.	N. Y.: Bad, 35.	Wis.: Bad, 15.	Total: Bad, 84.

Passing by answers to the first two questions, we will quote a few replies to the third which give the opinions of teachers as to the approved text-books.

What do you think of the "approved and indorsed" school physiologies?

ANSWERS FROM MASSACHUSETTS.

(Law liberal, but strictly interpreted.)

1. Not well adapted to work among the young children.
2. They are misleading, to say the least.
3. I disapprove of those I have examined. They seem often to be prejudiced and untrue.
4. I think them generally untruthful.
5. I think they contain many errors and false statements.
6. Emphasizing the evil effects is apt to fill the child's mind with such notions. A great many teachers with whom I have talked feel that better results could be obtained by teaching that emphasizes the normal rather than the abnormal.

ANSWERS FROM WISCONSIN TEACHERS.

(Law lenient.)

1. They are ill balanced and often strongly prejudiced and false to fact.
2. I think they are too strongly colored with preaching.
3. I think that the temperance matter is overdone, so that the subject-matter is likely to be neglected.
4. The printing, binding, and cuts are excellent. Most of the material is good. If not more than five per cent. of the alcohol paragraphs were introduced, — good.
5. They appear to be written to be "approved and indorsed," — to sell, and are really inferior books.
6. They are, as a whole, weak books "doctored," and made to pander to the demands of this society.
7. I think they have been made to sell, and that most of them are incorrect in statement and unscientific in treatment.

ANSWERS FROM NEW YORK TEACHERS.

(Law very stringent.)

1. Most of them are pernicious scientifically and ethically.
2. I find that according to our best authority, the successful physician, they are inaccurate and unscientific.
3. They are very much exaggerated.

4. They are worse than useless. They defeat the very object for which the Woman's Christian Temperance Union labors. They entirely suppress the few beneficial effects of alcohol and unduly exaggerate the evil effects. All youths pass through an age of unbelief, of cynicism, of agnosticism. This age generally comes during the latter part of the high school course. When they learn from authoritative sources of the benefits of alcohol, the reaction is marked. They immediately question the truth of the evils of alcohol, and term what the books teach "a lie." Such has been my experience.

5. In many cases they do not stand the search-light of scientific truth, besides containing disgusting details.

6. I should judge many of them to be extravagantly inaccurate as regards alcohol, according to the teachings of the University of ——.

7. So far as I have examined them, I believe them to be unscientific and in some instances ridiculous.

8. They are extreme, hence do not serve the purpose intended.

It is unnecessary to quote from the briefer answers, "Poor," "Bad," "Good," which constitute the majority of the returns; for they tell us no more than appears in the table. Our returns, on the whole, tend to bear out Dr. Jordan's statement, "Just in proportion to his ignorance of the subject will be the teacher's willingness to undertake the teaching of the New York law,"[1] that is, the teachers who give evidence of having reasoned and observed seem to have reached conclusions adverse to the "approved" text-books.

The final question as to results is naturally most important. From letters of the Department of Scientific Temperance Instruction, we learn that it is considered too early to expect results. This is remarkable, since, at the time of our inquiry, the law had been in operation in some States as long as fifteen years. Dr. Jordan has answered the question in the following emphatic manner:[2] —

> "The whole 'scientific temperance' movement is opposed to the movement for good schools through the choice of good teachers. It has been judged thus far mainly by its motives, which are good. It will come to be judged by its results, and these are bad."

In addition to such simple answers as are tabulated above,

[1] David Starr Jordan, "Scientific Temperance," *Appleton's Popular Science Monthly*, January, 1896, p. 352.

[2] *Loc. cit.*, p. 354.

we may quote a few of the New York replies which show the results of observation, and shed additional light on the subject.

ANSWERS OF NEW YORK TEACHERS AS TO RESULTS OF SCIENTIFIC TEMPERANCE INSTRUCTION.

1. I have seen evil results.

2. Good, when untrammeled; a failure, when hampered.

3. In my own judgment the effects of the teaching have been bad, for the reason that the manner in which the subject is treated kills the interest of both teacher and pupil in a science that is naturally interesting.

4. Bad, generally, in that the pupil often sees that the statements of the book are not literally in accord with his daily experience (and perhaps home training), causing him to lose respect for the books and impairing the influence of the teacher.

5. Bad, especially where the law is followed to the letter.

6. If the teacher is honest enough to teach the beneficial effects of alcohol, the pupil will believe the evil effects; then, and only then, are the results good.

7. The effect on the pupils seems to be that of regarding any mention of alcohol and its uses as a subject of ridicule.

8. Where a morally well-balanced instructor is allowed to use his discretion as to what to teach, — good.

CONCLUSION.

It is thus apparent that under the name of "Scientific Temperance Instruction" there has been grafted upon the public school system of nearly all our States an educational scheme relating to alcohol which is neither scientific, nor temperate, nor instructive. Failing to observe the distinction between the diametrically opposite conceptions of "use" and "abuse," some of its advocates have not hesitated to teach our children that the terrible results of a prolonged abuse of alcohol may be expected to follow any departure from the strict rules of total abstinence. The success which has attended the efforts of the Woman's Christian Temperance Union to secure the desired legislation may be readily explained by the sympathy sure to be felt by all intelligent people for any sincere attempt to combat one of the most gigantic evils of modern times. There can be no doubt that the abuse of alcohol is a threat to our civilization, and any honest effort to diminish its consumption is

certain to be welcomed without any very critical examination of the methods employed. That the originators of this educational scheme were honest in their intentions there is no reason to doubt, but they have violated sound principles of pedagogy in forcing subjects upon the attention of children at an age when their minds cannot possibly be adapted to comprehend them, and have shown themselves absolutely indifferent to the demoralization of our educational system resulting from forcing teachers to give instruction in a way which their experience has shown them to be ill adapted to accomplish the ends in view, and from compelling children to memorize statements sure to be contradicted by the experience of their later lives.

That the removal of this educational excrescence will be no easy task is evident from the result of the attempt in this direction made in Massachusetts during the session of the legislature in 1899, and described on p. 24–26 of this report. When it is remembered that the bill introduced by the Woman's Christian Temperance Union related to the teaching of a physiological subject in our public schools, the almost unanimous opposition of both the medical and the teaching professions is a circumstance of the greatest significance. The fact that after a series of hearings the Committee on Education made a report leaving the whole subject *in statu quo* shows that a prolonged struggle will be necessary to free our public school system from the incubus which rests upon it. In this struggle the Committee of Fifty should speak with no uncertain voice.

APPENDIX TO REPORT ON THE PRESENT INSTRUCTION ON THE PHYSIOLOGICAL ACTION OF ALCOHOL.

I.

In this appendix will be found, alphabetically arranged in groups, specimens of letters from American and foreign physiologists, obtained partly in answer to the request printed on p. 14 of the committee's report and partly in response to a special request directed to certain teachers of physiology who either were not present at the physiological congress of 1898, or who were unwilling to sign the statement there presented.

AMERICAN AUTHORITIES.

Dr. H. G. Beyer	U. S. N.
Prof. H. P. Bowditch	Boston.
Prof. R. H. Chittenden	New Haven.
Dr. F. W. Ellis	Monson, Mass
Dr. G. W. Fitz	Boston.
Prof. Theo. Hough	Boston.
Prof. W. H. Howell	Baltimore.
Dr. P. A. Levene	New York.
Prof. L. B. Mendel	New Haven.
Prof. H. Sewall	Denver.
Prof. G. N. Stewart	Cleveland.

Dr. Henry G. Beyer, New Bedford, Mass., October 9, 1897.

In my experiments on the direct action of certain drugs on the heart and blood vessels, made at the Johns Hopkins University, ten years ago, and, before mastering the various steps necessary in the successful operation for the isolation of the dog's heart, according to Martin's method, I made a few experiments with alcoholized blood on the heart and blood vessels.

Assuming that the physiological organs, under experimentation, were chiefly muscular, and, by carefully observing the doses, I should say *positively* that the first effect of alcohol

stimulates, the next effect of alcohol paralyzes the muscular structures involved. The stimulating effect, however, is so slight and temporary that it is far outweighed by its subsequent paralyzing effect: the heart is arrested in diastole and the blood vessels become dilated (when isolated from the central nervous system) beyond recovery, when the doses were large enough and continued long enough. The dilatation of the blood vessels is especially marked in the frog's web and can be directly measured under the microscope, when alcohol is used in proper dilution and injected into the lymph sac with normal salt solution.

The fact that alcohol at first stimulates and then paralyzes, in other words, first increases, then decreases, blood pressure, or first causes temporary contraction and then a more prolonged relaxation of the muscular fibres of the heart and blood vessels, explains many of the phenomena in all the other organs, in which blood vessels are found and of which the temporarily increased mental activity is perhaps the more important.

. . . .

As regards the pharmacological side of the question of the administration of alcohol, it is not difficult to find pathological conditions in which the administration of alcohol is directly indicated, and in which, moreover, no remedy might answer as well as alcohol. In a perfectly normal animal organism, however, I cannot understand any good effects producible by alcohol.

In my *opinion*, alcohol is *not* a food, nor even a condiment. It is a stimulant of value only in pathological conditions, and should be used, therefore, as a remedy only.

The introduction of alcohol physiology into the elementary school courses is, in my opinion, an example of mistaken public benevolence which has nothing but the good motives of the originators to commend it, and which illustrates the dangers of people meddling with things they do not understand.

The most perfectly cooked meal, on a most properly appointed dining-room table, served by the best dressed professional waiters, while most attractive and beneficial for grown people, would be of no use for the starving suckling.

The best established and most important biological facts cannot be comprehended by the infant or child-mind, nor

properly assimilated, any more than a beefsteak can be digested by a suckling infant. I place the lowest limit of age for the beginning of the study of biology at fourteen years and that of elementary physiology at sixteen years. I agree perfectly with the idea of the promoters of alcohol instruction that a knowledge of the pernicious effects of alcohol can only be obtained and thoroughly comprehended when engrafted upon a brain already cultured with a sound knowledge of physiology.

The best that can be done in the primary and grammar departments is to warn children of the dangers of alcohol as we warn them of bad company, of swearing, of telling lies, or of the dangers of mad dogs, etc. In other words, teachers might begin by working on their sentiments in the absence of their understanding, but great care should be taken to *avoid all untruths and exaggerations* with regard to alcohol and its effects. Nothing which could not later on be verified by the children themselves should ever pass a teacher's lips.

I have examined many of the so-called physiologies written especially for alcohol instruction, and can approve of none. Martin's is, however, the best among them.

Professor H. P. Bowditch, Boston, September 29, 1897.

In reply to your letter of September 24 I would say that I have always taught that alcohol, since it is, in moderate doses, almost wholly used up in the body, must be regarded as a force producer or a food in the same sense that starch and sugar are foods, but with this important difference, that, while starch and sugar can be ingested in amounts limited only by the power of the system to digest and absorb, alcohol, owing to its peculiar action upon the nervous system, cannot in health be taken in an amount sufficient to render its nutritive value of any importance. In certain pathological conditions, however, this action upon the nervous system seems to be held in abeyance, and we accordingly find cases of convalescence from exhausting diseases in which the system seems to tolerate large quantities of alcohol and to be not only stimulated but actually nourished by it.

A most remarkable case of this sort is reported by Dr. S. L. Abbot of the Massachusetts General Hospital. It is that of a

young woman suffering from double pneumonia who refused to take food and who seemed at the point of death. A teaspoonful of brandy and water, forced between her teeth, seemed to produce a beneficial effect, and orders were given to let her have all the brandy she would take. For the next seven days she lived exclusively on brandy and whiskey, consuming in all over a gallon of distilled liquor without showing any signs of stimulation. As she received no other food the conclusion that she was nourished by the alcohol seems almost irresistible. She finally made a good recovery.

The action of the drug upon the nervous system is mainly that of a narcotic poison. The initial period of stimulation is perhaps a reflex phenomenon due to the contact of the drug with the mucous membrane of the alimentary canal, though the possibility of a direct stimulation of the tissues by the alcohol in the circulating blood cannot be excluded.

Professor R. H. CHITTENDEN, New Haven, Conn., October 5, 1897.

Your series of questions pertaining to alcohol remind me of the pamphlets we are wont to receive from Washington on educational matters, in which the list of questions is so broad as to be appalling. I will do my best, however, to answer a few of the questions contained in your letter.

First: I believe that we have abundant evidence that alcohol has a certain food value; that when fed under suitable conditions, i. e., in not too large amounts at one time, it is oxidized in the body, playing the part of a non-nitrogenous food. Like the latter it is capable of diminishing somewhat the amount of proteid food required by the body. Owing to its peculiar nature, however, i. e., its ready absorbability, it is rapidly eliminated from the body when taken in large doses, and as a result only a portion of the alcohol so ingested can be utilized. In such cases the food value which alcohol possesses is lost sight of in its more pronounced action as a stimulant. There is, I think, no doubt that this energy which comes from the oxidation of alcohol in the body can be utilized as a source of work, although it is doubtful if alcohol can be considered of great value in this direction since its stimulating action is so much more marked. Further, when taken in small doses heat unquestionably results from its oxidation, although at the same

time it is to be remembered that there may be an increased loss of heat from the action of alcohol upon the cutaneous blood vessels. As regards its action upon metabolism, I believe that much depends upon the dosage and the personal idiosyncrasies of the individual, and that these two factors are in great part responsible for the apparent divergence in results attained by different investigators. That as a food it differs from ordinary non-nitrogenous food is shown by its specific influence in many cases, as upon the production and excretion of uric acid.

Alcohol has a certain positive influence upon digestive action. In small quantities it increases slightly the digestive power of saliva and of gastric juice, or, to be more exact, it may do so if the digestive power of the secretions is up to normal. With larger quantities of alcohol the digestive power of saliva, gastric juice, and pancreatic juice is greatly inhibited, the extent of inhibition depending upon the relative strength of the secretion and the proportion of alcohol present. How far this inhibitory action is counteracted by increased secretion under the influence of alcohol I do not think we know at present. Alcohol certainly does increase the rate of secretion of gastric juice, at least in the dog, and it also has a marked influence in increasing the rate of absorption from the stomach of various diffusible substances, such as peptone, sugar, salts, etc. I believe we can safely say that alcohol in small doses is frequently useful as an aid to digestion, especially in certain semi-abnormal conditions.

I also think we are warranted in the general statement that strictly moderate doses of alcohol, while not needed by the healthy individual, are not harmful under ordinary conditions of life, and that small doses may even prove beneficial, at least under some conditions. Taken in large doses on the other hand, i. e., in excess, intoxication and even death may result, if the dosage is sufficiently large. Further, the long-continued use of large quantities of alcohol may without question produce marked lesions of the stomach, liver, blood vessels, brain, nerves, etc., the intensity of action depending much upon the quantities used and the personality of the individual.

As a stimulant, alcohol is without doubt of great value in many acute diseases running a limited course where it is necessary to have recourse to something to keep up the patients'

strength until the crisis of the disease is past, but unquestionably alcohol acts differently with different individuals. As Lauder-Brunton says, observation alone can tell whether the administration of alcohol — in fevers, for example — will be advantageous or not, but in many cases alcohol is certainly exceedingly useful both as a cardiac and a general stimulant.

Second: In my judgment the introduction of "alcohol physiology" into elementary public schools is absolutely useless. The children are not sufficiently advanced to profit by the instruction given, even if the latter is good. There is no propriety in teaching any form of physiology before the child has acquired some knowledge of chemistry and physics. To teach physiology to children who have not had this preliminary training is simply to present them with a collection of isolated statements which convey little or no meaning to their minds. They may memorize them, it is true, but lasting impressions will hardly be made.

I have very little definite knowledge of the various physiologies used in the schools; two or three that I have seen have not impressed me favorably. One in particular contained several statements regarding the action of alcohol in producing diseases, such as cirrhosis of the liver, which I fancy would be hardly intelligible to the average child.

Dr. F. W. Ellis, Monson, Mass., October 12, 1897.

I fear that I cannot offer anything authoritative concerning the physiological effects of alcohol. Some years ago I made quite a careful study of the subject, but at present I am not abreast of the newest work in this line.

I am a believer in the therapeutic value of alcohol, although its use as a medicine is undoubtedly abused at times.

I believe that it is nonsense to attempt to teach the physiology of alcohol in the public schools. I believe that the temperance cause is likely to be injured rather than advanced by such instruction. I have not examined carefully any of the approved temperance physiologies, but I am confident that the time to write such books has not yet arrived. Until scientists are agreed as to the effects of alcohol on the animal functions, and until the subject has been clearly worked out by unprejudiced investigators, I think it will be a waste of time to endeavor to

enlighten children in those matters. Few, if any, teachers in the public schools are qualified to teach any branch of physiology as it should be. I am certain that the average teacher will make a sad mess in attempting to impart instruction in the obscure subject of the physiology of alcohol.

The temperance question, in its essence, is a moral and not a physiological question. I believe that any attempt to teach the physiology of alcohol in elementary schools is likely to induce the pupil to lose sight of this essential fact.

Dr. G. W. Fitz, Cambridge, Mass., October 30, 1897.

. . . .

As to the inquiries in your letter of September 28, I cannot now reply in full. Concerning the body of effects relating to alcohol essential to the education of medical and university students, I should consider it sufficiently well established that the use of alcohol as a beverage was harmful and that it is wiser for any one to avoid its habitual use. I doubt if the occasional use of moderate amounts has any particular effect, that is, amounts entirely physiological, showing no immediate toxic effect.

As to the value of alcohol as a food I believe that in certain conditions it has a distinct food value, but its use should be limited to a physician's direction. As a medicine I believe it has undoubted value. As a condiment for sauces and similar articles of food, I believe it is a perfectly legitimate use, and if used in moderate amounts I see no reason why it should create an appetite for liquor; I have no personal knowledge of any case where such has arisen. Its influence upon tissues, organs, and physiological processes I have no time to go into. I have not the time to go into the list of points claimed by the Scientific Temperance people which are not sufficiently well proven to form part of our teaching material. "They are too numerous to mention."

I do not believe that the study of the physiology of alcohol should be introduced into any course below the high school. I do not believe it should be made compulsory by state law. So far as I have been able to observe the results of the instruction in physiology of alcohol, I believe that it is bad rather than good. The arguments against such teaching are (first) the

children have no basis in chemistry and especially physiology for any study of the physiology of alcohol: therefore at once it has no educational value, as it is beyond their comprehension, so as a "scientific study" it is a misnomer and absolutely valueless. I believe that such teaching is unpedagogical and distinctly bad for all the other studies, as it gives children the idea that they can study and reason about things which are entirely beyond their comprehension. Again, this study suggests possibilities of experiment with alcohol which may result in just what it is hoped to prevent. I believe that the strongest arguments should be the positive ones, that no one can afford to do anything that will not further his best life. Children can comprehend the social effects of the use of alcohol, the economic and to a certain extent the hygienic aspects of its use, and the influences of such observation and study have far stronger effect in shaping their lives than any amount of scientific study. When the child is taught that the use of alcohol as a beverage may lead to coarseness, brutality, loss of control, bring about unhappiness to the family, make the individual who might otherwise be helpful and kind a selfish brute who may do injury, even murder, and that the individual who does not use alcohol is brighter, happier, able to do more work and to be more helpful in society, he has the main facts, and has certainly the chief stimulus to abstaining from its use.

Professor THEODORE HOUGH, Boston, October 4, 1897.

I cannot pretend to an adequate acquaintance with the very extensive literature of the physiological effects of alcohol, but have seen enough of it to recognize that there is much unnecessary confusion introduced by not distinguishing between the effects of pure alcohol and the effects of the various alcoholic drinks in common use. Among the points which seem to me "sufficiently well established" are: —

1. Its action in causing cutaneous dilation and so increased loss of heat from the body. This is probably the cause of its undoubted efficiency in the early stages of internal inflammation processes, such as colds or intestinal troubles.

2. It is oxidized within the body to a certain extent. I suppose the amount of oxidation varies to a certain extent with different individuals, but it has been more or less accurately de-

termined in certain individual experiments. What is not oxidized is excreted through the lungs and the kidneys.

3. It seems to be in all cases a strong diuretic, although the marked diuresis of some drinks, such as beer, must be due as much to the other substances which they contain as to the alcohol.

4. It acts at times as a direct stimulant, although I am inclined to think that many of its effects classed under this head are in fact due to other actions. Thus in the case of internal inflammation — or, perhaps better, congestion — its medical value is probably due to the changes it produces in the distribution of the blood to the various organs of the body and the consequent changes of blood pressure or blood flow in the congested organs, rather than to the "stimulating" action, which "helps the organ affected to make an increased effort to meet the unfavorable conditions under which it is laboring." This has always seemed to me to be a very loose method of explaining such phenomena. Even with regard to its stimulating action on the nervous system, it seems to me to be an open question whether this is due to the direct action of the drug on the nerve cells, or to a rearrangement of the conditions of the organism as a whole. In fact, this whole subject of the relation of the vascular changes to the action of the drug on the nervous system has not received the attention which it deserves. For instance, what accurate experimental knowledge have we of its effect upon the cerebral circulation? In short, it seems to me that the so-called stimulating action of the drug needs to be investigated much more carefully than has been done in the past.

5. Certainly some of the alcoholic drinks when taken into the stomach dilate the vessels of the mucosa. Whether this is an aid to digestion or not is another question.

Among the points which seem to me insufficiently proved to form part of any didactic teaching I should certainly include the whole question of its effect upon general metabolism, — the production of carbonic acid, for instance. Such experiments are so complicated that it requires a good physiologist to understand their significance, and often, I fear, the best physiologists can only be impressed with the confusion of the whole matter as it stands at present.

After all, the practical point is not so much the effects of a

single dose of alcohol as the ultimate effects of its long-continued, moderate use. The pathological lesions resulting from excessive use are reasonably well known, we want more accurate information as to the regular use of small or moderate doses through long periods of time, and you have done us a great service in carrying out the experiments upon cats and dogs recently published. If similar experiments could be made which would extend your results to the effects on the various physiological functions, such as the more important reflexes, the activity of the digestive juices, etc., we might feel that we had a real practical physiology of the subject. But the labor of such researches would be almost superhuman.

As to the second part of your question I can say that I do not believe at all in the so-called "Scientific Temperance Instruction," and that chiefly for three reasons: First. It is absurd to expect the teachers in our public schools to have that acquaintance with the results of scientific labor on the subject which alone would enable them to deal intelligently with the practical question at issue. They cannot get this knowledge from our "temperance physiologies," the majority of which are written to supply the demand for a certain definite teaching and are evidently written by men (or women) with no real knowledge of the subject at issue. I have examined many of the "approved and indorsed" physiologies, and I have always ceased their perusal with feelings of pity for the conscientious teacher who is dependent upon them for information as to the physiological side of the problem. Only a well-trained physiologist is capable of stating the real facts, and in the nature of things the average teachers in our public schools cannot be "well-trained" physiologists.

Second. The great argument against the use of alcohol is the danger of contracting the habit. That is a moral question and does not need enforcement by any teaching of the physiological effects. I have nothing to say against some sort of temperance instruction in the schools with this feature prominent; but I do not believe that if this fails of effect with the pupils, the so-called scientific teaching will do any good. In other words, as a matter of practical education, from the temperance standpoint, it is attacking the question in the wrong way.

Third. From the standpoint of personal hygiene such teach-

ing is one-sided. Only a certain amount of time can be given to the teaching of personal hygiene in our schools, and, as it is, that time is now taken up almost exclusively with the teaching of the effects of alcohol upon the system. I have yet to meet a student of our high schools who could give any account of muscular exercise, or sleep, or proper attention to diet, clothing, bathing, or mental activity, as agents in the maintenance of health. Hygiene to them was only the "use and abuse of stimulants and narcotics." I believe it is possible to give such instruction in physiology and personal hygiene which shall be of real use to the pupils in the subsequent care of their health. But this is out of the question so long as the time necessary for such instruction is monopolized by temperance teaching. The whole is greater than the part, and we are to-day absolutely neglecting everything but one part, and, it may be added, we are doing that part in an utterly inefficient manner.

Professor W. H. Howell, Baltimore, October 14, 1897.

. . . .

I do not believe that the physiological value of alcohol as a food has been either demonstrated or disproved — its value as a condiment and as a stimulant I believe is indicated by experiment and medical experience, to say nothing of the accumulated experience of mankind — provided always that the quantity used is not too great for the particular organism it is used upon.

The points that seem to me unsettled are the precise effect of the alcohol in large and small quantities respectively upon digestion and metabolism. These points, I believe, cannot be settled otherwise than such points are usually settled, namely, by the accumulated results of experiments from many observers.

As to the second point, I have at different times examined a number of the "approved and indorsed" temperance text-books. I am strongly of the opinion that this whole method of treating total abstinence is a mistake. The argument in my mind is simply this: About the excessive use of alcohol there is no division of opinion. About the fact that those who begin to use alcohol moderately incur the danger of becoming victims to its excessive use there can be no difference of opinion, but the physiological reason for this fact cannot be furnished. It

is proved abundantly simply by the facts of human experience, and for the purpose of teaching temperance that is quite sufficient. The effects of a moderate use of alcohol, that is, the direct physiological effects, are not accurately known, and if the matter is discussed at all the evidence on both sides should be given. In my opinion the great objection to the books in question is that they assume that alcohol in all doses is injurious to the organism and treat this as a truth that is established by scientific experiments. They violate the fundamental principle of scientific inquiry in treating as proved what is still undetermined. My own feeling in the matter is this: If the community believes that it is the duty of the public schools to teach temperance, or rather total abstinence, — and as to this I have not wholly made up my mind, — then let the teaching be based not on a pseudo-scientific basis, but on the experience of mankind. Most men will admit that drunkenness is a bad thing, and that he who drinks is in danger of becoming a drunkard: but to attempt to prove scientifically, in a form suited to the minds of the young, that he who drinks necessarily injures himself physically is an impossibility. It can be made apparently successful as a logical argument only by violating the truth in the premises laid down.

Dr. P. A. Levene, New York, November 13, 1897.

I greatly regret that the state of my health does not permit me to answer the questions contained in your letter as fully as I should have liked to; but I consider the subject of such importance that I desire to add a few words to all the other answers received by you, in order to record one more vote against the too frequent administration of alcohol by the physicians of the U. S. A.

As to the use of alcohol, there are two ways of its consummation by individuals. One, as a food or a constant stimulant to digestion during meals (so to say its "chronic use"), the other as a stimulant in the course of acute diseases, such as fatigue, temporary indigestion, etc. (its "temporary use").

As regards the first, the views of men of science on the subject are pretty harmonious — they are hardly favorable to the use of the too dangerous food, though it is largely advertised by practitioners.

I do not wish to describe here fully the symptoms of chronic alcoholisms of the anatomical changes — the organs, etc., but I shall characterize them all in a few words, demonstrating at the same time the physiologic meaning of those changes.

The chief aim of medicine is, in fact, to preserve the vigor of the organism, its strength for the struggle with unfavorable and frequently hostile surroundings, and every physician knows that old age is the most unfavorable condition in our struggle with diseases.

But can the age of the organism actually be measured by the number of years lived by a certain individual? By no means. By age, as a factor in the struggle of the organism with the surroundings, we understand a certain condition of the tissues of the organs.

My late great master, Professor Botkin, St. Petersburg, used to say that the age of a person is determined by the relative amount of connective tissue and specific elements (cells) in the organism.

And no other remedy taken *a la longue* destroys so easily the various tissues, leaving in their place connective tissues, thus causing premature age of the individual, as does alcohol.

This fact will be readily understood if we bear in mind the great osmotic power of alcohol in comparison with tonics and stimulants of a more complicated chemical composition (Overton).

This result of chronic alcoholism is a long-established fact; it is also a well established fact that it is sufficient to consume but very small doses of alcohol, taking them regularly day after day, in order to belong to the legion of chronic alcoholics.

And if, after all, medical men do prescribe alcohol, it is because they believe in its power to stimulate the appetite and digestion.

It is unnecessary to enter into great detail as to that supposed property of alcohol. Suffice it to remark that no experiments on alcohol and its influence on digestion (Chittenden and Mendel, for instance) have ever disclosed any beneficial effect of it.

And if we find a good many persons who cannot eat and digest without alcohol to their meals, that fact is to be explained chiefly by the pathological condition to which they have reduced

their organism by constant use of alcohol. Such individuals actually do digest better using alcohol to their meals than without it, as was shown by a number of works in the clinics of St. Petersburg.

But if many physicians who do see the danger of using alcohol as a food, and its irrationality, and who agree with the views on the use of alcohol so well expressed by Professor Bunge, will still adhere to the use of alcohol in acute diseases, I can only repeat all I said a little above about the influence of alcohol on the digestion. I mean to say that there are no research works proving the advantage of using alcohol in preference to other stimulants in the course of acute diseases, and, on the other hand, there are research works proving that the acute diseases take a much worse course with the use of alcohol, — that the digestion, upset by the disease, is being still further harmed by the addition of alcohol to the toxines developed in the organism, and the digestion is one of the principal factors we have to care for during acute diseases. (I am sorry I cannot enumerate the authors of the researches mentioned, which were done about six years ago, as I am too far from my home and my little library, where I have the entire literature on the subject.)

The question of the action of alcohol on the heart and kidneys, especially in fever, is even less investigated than the influence of alcohol on the digestion in the course of acute diseases; still we know that the issue of the disease depends on the condition of those organs more than on anything else.

I do admit that the number of research works is very limited, that the difference of opinion on the question in different countries is very great; still, to my mind, the student should be taught to prefer the use of remedies whose influence has been more carefully studied than that of alcohol.

There is one other point I should like to answer, and that is, whether the study of the physiological influence of alcohol should be introduced into elementary schools, and within what limits.

In fact, I hardly believe it possible to instruct a teacher as to how much of a certain truth he is to tell to his pupils, young as they may be. It is not a question of quantity; it is a question of the form in which it is communicated. All we can

tell to the student, we can also tell to the primary boy, if we know how.

I shall also not dwell at any great length on arguments as to the efficiency of this method of preventing alcoholism, but shall only mention —

1. There is no better weapon in the struggle against evil than knowledge.

2. Of all we learn, we retain longest in our minds what we have learned in the days of our youth (on the principle of the law of reflexes).

3. If only one child out of hundreds shall be saved by this method from alcoholism, the work will be worth doing.

By all that I do not mean, however, to say that the teaching of the influence of alcoholism on the organism is the only or best way of preventing alcoholism.

I hope you will pardon the shortness and superficiality of my answer, as I am, I repeat, too ill to work up the question as fully as I should have liked to.

As to the instruction on the subject in the elementary schools, it is certainly understood that the influence of alcohol as a food only has to be considered, i. e., its use in hygiene, and not as a medicine.

Professor LAFAYETTE B. MENDEL, New Haven, October 7, 1897.

In response to your invitation I offer my "testimony" concerning the topics suggested in your letter. I need not add that there is "much to be said on both sides."

I. (a) Ethyl alcohol, introduced into the system in moderate doses, is burned up, only a small part being excreted as such. Comparative experiments on nitrogenous metabolism and respiratory exchange seem to show, on the whole, that the oxidative changes in the body are scarcely affected by moderate doses, i. e., such as do not interfere with the normal functions: and in such quantities alcohol seems to behave precisely like a non-nitrogenous food stuff. Inasmuch as even moderately large doses of alcohol have certain peculiar disturbing effects upon the normal actions of the organism, alcohol can be assigned only a very limited importance as a food, and its use must be considered from other standpoints.

(b) That alcoholic fluids (especially the weaker ones) form

important condiments must, I think, be admitted. When it is remembered how largely the accessories to our diet determine the amount and character of the food ingested, and furthermore, how universal is the use of condiments, it is eminently fair to compare the alcoholic drink with the other common accessories. They all agree — and here, again, when taken in appropriate quantities — in exerting a more or less marked action on the nervous system, upon the digestive functions, upon psycho-physical states, e. g., weariness, etc. The alcoholics differ markedly only in one respect: the danger of excesses is decidedly greater. Considerable testimony of a definite character might be added regarding the action of alcohol on the digestive functions, a subject upon which Professor Chittenden and myself propose to present some experimental data at another time.

(c) Alcohol — in physiological doses — is a typical stimulant and examples readily suggest themselves of its service as such. I am not inclined to agree with those physiologists (e. g. Bunge) who assign to it a depressing action exclusively. Its action is of short duration, and herein lies a danger. Further, its use must be modified in many instances, owing to peculiarities of the individual rather than the agent; but in this respect again alcohol shares a quality common to the majority of substances employed like it. I cannot refrain from quoting a few words from O. Funke which always seem to me to be worthy of repetition in this connection. He wrote, —

"It is foolish and unjustifiable to put a stop to even the most moderate enjoyment of the aforementioned stimulus. One does not need to have recourse to the argument that the inclination to acquire it in some form or other is really the expression of an inextinguishable human instinct which has made itself felt in all ages and by all peoples. One needs only to ask: Must our machine, then, always work in the same monotonous, tiresome tempo as the pendulum of a clock? What harm is there if from time to time it pumps somewhat more quickly under a higher pressure of steam if subsequently, during a period of slower work, it can make good this slight unnecessary expenditure of force by drafts from an abundant store of energy, and repair any small damage which its mechanism may have suffered? It is certainly a fact that many a bright fruitful idea has been born from a large glass of fragrant Rhine wine which, perhaps, would never have

come from the water jug of a vegetarian. Many a bitter heartache, which would have eaten deeper and deeper by drinking raspberry-lemonade, has been softened by a nice cup of coffee; many a trouble, many a care, has disappeared in the smoke of a cigar, — and that is surely worth something in this poor human existence." [1]

(d) With reference to alcohol as a medicine the clinician alone is entitled to speak with full authority. Every one knows what extensive lesions of various organs excessive "doses" of "alcoholics" may give rise to. But the "physiological," therapeutical, and pathological properties of alcohol deserve as distinctive treatment as does, for example, the consideration of arsenic as a drug and as a poison.

The preceding is intended to indicate very briefly what topics I consider sufficiently well established and important to present to the university student. The pharmacologist and pathologist will doubtless present other points of view. The majority of the better books wisely omit any discussion on those topics regarding which experimental data are largely wanting or unsatisfactory (e. g., comparative action of various alcoholic drinks on renal secretion or excretion). And in the university, at least, let us not make the mistake of some public-school enthusiasts in conceiving of physiology and the study of alcohol as complementary or equivalent subjects.

[1] "Es ist thöricht und unberechtigt auch den bescheidensten Genuss der genannten Reizmittel zu verwerfen. Man braucht sie nicht damit in Schutz zu nehmen, dass der Trieb sie in irgend welcher Form sich zu verschaffen, wiederum der Ausfluss eines untilgbaren Menscheninstinctes ist, der sich zu allen Zeiten und bei allen Völkern geltend gemacht hat. Man braucht sich nur zu fragen: Muss denn unsere Maschine, wie das Pendel der Uhr, immer in demselben monotonen langweiligen Tempo arbeiten? Was schadet es ihr denn, wenn sie von Zeit zu Zeit mit etwas stärker gespanntem Dampf etwas rascher pumpt, sobald sie nur in den darauffolgenden Intervallen bei langsamerer Arbeit die Kleine Luxusausgabe von Kraft aus dem genügenden Vorrath wieder einbringen und etwaige Kleinere Defecte ihres Mechanismus wieder ausbessern Kann? Wahrlich manche leuchtende fruchtbringende Idee ist schon aus einem Romer duftenden Rheinweines geboren, welche vielleicht nie den nuchternen Wasserkrügen der Vegetarianer entstiegen wäre; manch bitteres Herzweh das bei Himbeerlimonade tiefer und tiefer gefressen hätte, hat ein Schälchen Kaffee gemindert; manche Sorge, manche Grille hat sich mit dem Rauch einer Cigarre verflüchtigt, und das ist doch etwas werth in so mancher armseligen Menchenexistenz."

II. I cannot uphold a system of instruction in physiology which leaves in the pupil's mind as the uppermost thought regarding the *function* of the *human body:* Avoid drink. I am in thorough sympathy with any justifiable movement to prevent the spread of alcoholism; but I cannot uphold the farce of "scientific temperance instruction" which has received the sanction of the law. Physiology and hygiene should be taught *as such* in our schools. The evils of intemperance may be treated by themselves, if necessary, along with habits that may become "bad" habits. Physiology should remain a true science, stating facts of observation and not those presumed or enforced by law. I am familiar with a number of the so-called "indorsed" physiologies (Steele's, Hutchinson's, Stowell's, Thatcher and Morrill's), the worst of which is perhaps the one "prepared by order of the General Assembly of Connecticut." Furthermore, the teachers are frequently incompetent to discuss the pharmacology of alcohol. Thus, one text-book prescribed for children of *seven* years states "that the subject is presented in language that can be *readily* understood by *children*, and in the form and order best adapted to objective teaching." In speaking of the effects of alcohol on the digestive system, the book has sentences like this: "The liver may become inflamed and permanently changed in its tissues, producing the diseased condition called cirrhosis with the resulting dropsy of the abdomen." A teacher using this book (prepared in compliance with chap. cxxxix. 1886 Conn.) was asked by me how she would illustrate the properties of alcohol as the *physiology* demands. "Burn some," she replied, with hesitation, "to show its inflammable qualities. It produces inflammation." It happens that I myself was subjected to a course in temperance physiology at the age of twelve years. The instructor illustrated the influence of alcohol by dropping the undiluted white of an egg into at least five or six ounces of strong rum, calling attention to the solid precipitate, and concluding that as the lining of the stomach is albuminous, therefore this coagulating action is repeated when liquors are ingested. Precisely such an illustration is to be found in Steele's "Physiology," on page 129, the author adding that "the brain is largely albuminous substance." Another book, widely used, says: "There is no such thing as a temperate use of spirits. In any quantity they

are an enemy to the human constitution." Stowell's "A Healthy Body" begins with the chapter, "What is Alcohol?" the keynote being: alcohol is a poison. A college student who had learned the alcoholic physiology in the New York city schools was asked what he understood the action of alcohol to be. He informed me that it served "principally to form fat, which is useful in the body."

I speak of these examples to illustrate some of the unfavorable results of the present methods. The commonest error consists in giving universal application to facts which apply to definite conditions alone. An untruth once discovered by an individual will make him doubly skeptical. The obvious absurdity of some of the text-book discussions is certain to bring harmful results and at the same time to injure the proper study of physiology and hygiene.

Physiology must be upheld as a science: and every science aims at the truth. If "temperance instruction" cannot be made to conform to scientific methods, then it must create a department for itself. Finally, I can scarcely believe that the means and methods at present adopted are justifiable, whatever the end in view. Man is by nature a temperate animal, and it is only by distinguishing between temperance and intemperance (i. e., use and abuse) that the evils of alcoholism can be combated. Present methods fail in this respect.

Professor HENRY SEWALL, Denver, Colo., October 10, 1897.

I am very glad to reply to your circular dated the 1st inst., not that I can give answers either pertinent or valuable, but at least that I may express appreciation of the work you have been doing, as evinced in the reprints sent me from time to time. I have at times formulated opinions regarding the matters touched in your two encyclopædic questions, but the data on which my opinions would have to be founded are widely scattered.

There is only one suggestion I feel qualified to advance, and that is in regard to the method commonly used in the ordinary "temperance" text-book of physiology in impressing the evils of alcohol, etc. In these works the truth, or what there is of truth, is presented with such partiality for total abstinence, with such magnification of the evils of any indulgence, so little

discrimination between the effects of stimulants and narcotics employed in therapeutic and poisonous doses, that the idea given the pupil is necessarily deliberately false. I seriously believe that more evil will probably accrue to the next generation through this legalizing of lies than would result without direct effort for moral teaching. This is an opinion which has spontaneously asserted itself in me from time to time in looking over school physiologies: I have tried to get a number of such books for more critical review, but they are not at hand. I do not by any means mean to make my strictures universal. One could hardly wish a sadder picture of, or more powerful plea against, the evils of intemperance than that to be found in the junior editions of Martin's "Human Body."

Professor G. N. STEWART, Western Reserve University, October 10, 1897.

I think the little I know about alcohol in its physiological relations stands very much as I put it in my "Manual of Physiology," pp. 413, 414.

I believe it is unwise to attempt to teach ordinary school-children pharmacology. To attempt to teach the pharmacology of a single substance, whether alcohol or any other, without the sure foundation of adequate physiological knowledge, seems to me absurd; and the manner in which the attempt is made in school "Physiologies" in this country further to be, as a rule, dishonest, or at least disingenuous.

I believe that it is the office of parents, in the first place, and of clergymen and Sunday-school teachers, in the second, to warn the children of more mature age, on fit and not too frequent occasions, of the moral, social, and hygienic evils of excessive use of alcohol.

Finally, I do not believe that it is the lack of knowledge of "the physiology of alcohol" which is responsible to any great extent for the existence of intemperance. Nor do I suppose that the amount of drinking in one of the most drunken parishes in the North, the habits of whose population have been intimately known to me for more than twenty years, would have been greatly lessened by any exposition of the histological or physiological changes produced by alcohol in the kidney, liver, or brain that an omniscient school-teacher could have

given in the parish school. But an amelioration in the material condition of the people, due in part to wise legislation in regard to the tenure of land, the spread of education, the establishment of libraries, and the efforts of temperance societies to provide entertainments that act as a counter-attraction to the public house, have brought about, within the period which my memory covers, a gradual but encouraging change for the better.

ENGLISH AUTHORITIES.

Sir T. Lauder-Brunton	London.
Professor T. J. Clouston	Edinburgh.
Sir Michael Foster, K. C. B.	Cambridge.
Dr. Arthur Gamgee	Montreux.
Professor W. D. Halliburton	London.
Sir J. Burdon Sanderson, Bart..	Oxford.
Professor E. A. Schäfer	London.
Dr. P. H. Pye Smith	London.

Professor Sir T. Lauder-Brunton, London, October 22, 1897.

My views in regard to the physiology of alcohol are expressed in my text-book on Pharmacology, but are also given at greater length in my article on "Stimulants and Narcotics" in Cassel's "Book of Health," as well as in the book on "The Alcohol Question," Contemporary Controversies Series, published by Strahan & Co., 34 Paternoster Row, London, which contains a reprint of articles by several authors from the "Fortnightly Review." I have also mentioned some views in regard to the prevention of drinking in "The Bible and Science," a copy of which I now send to you. I doubt very much if instruction to children in the physiology of alcohol would do them much good, and especially if repeated lessons would be of much benefit. I should think that more could be done to prevent their taking alcohol, by exciting their imagination and appealing to the fighting instinct by showing them that it was a brave thing to resist the temptation to alcohol, and a weak and cowardly thing to yield to it.

Professor T. J. Clouston, Edinburgh, October 26, 1897.

In reply to your letter of the 20th September regarding the Alcohol problem, I would, without attempting to cover the whole ground, briefly enumerate my views as follows: —

1. Alcohol in small doses is a true stimulant to the mental cortex, increasing markedly the intellectual and emotional intensity in most persons.

2. The function of inhibition is always weakened, however, by it in any dose, large or small, and this constitutes its greatest danger.

3. Whenever there is a neurotic heredity or diathesis, the results of small doses of alcohol are especially dangerous from the intense feelings of pleasure it has the power of producing, and the strong craving for a repetition of the dose and for larger quantities it is apt to excite.

4. Therefore neurotics of every kind should especially be on their guard against alcohol. Most of them should be teetotal.

5. It causes in large and continued doses demonstrable and mostly incurable changes in the brain neurons, the vessels, the lymphatics, and the neuroglia, — changes that are inconsistent with sound mental activity, with morality, and with average social conduct.

6. Alcohol is a food, and may in a diluted form be a very valuable adjunct to ordinary foods, by exciting appetite, by improving digestion, and by stimulating certain nutritive processes, e. g., the laying on of fat.

7. As a drug it is essential in medical practice.

8. As a luxury, a producer of subjective feelings of happiness and organic satisfaction, it seems to me to be perfectly legitimate if it is used in strict moderation and its dangers are kept in mind and avoided. Many human beings have none too many sources of happiness and are entitled to run some risks even in securing it. Burke hesitated to condemn the poor London gin drinker on this ground.

9. Human nature has in all its history never been content with mere "bread and butter," the "ale" was invariably craved for and got as soon as the "cakes" were secure. Primitive man whenever he had a "feast" introduced alcohol or some brain stimulant in some shape or form as an adjunct to feasting, and all his successors have done the same.

10. It is in my opinion at least an arguable point whether if all the pleasure given, all the stimulation to social instincts, and all the drowning of care produced by alcohol in rich and poor were summed up and weighed and put in the scale on one

side, and all the harm done by it put in the other scale — whether the result would not be in favor of the alcohol; and if opium, tobacco, Indian hemp, tea and coffee, and cocoa were added, it seems to me clear that the vote must go for brain stimulants.

11. I think plain dogmatic teaching as to the risks and real uses of alcohol should be given by teachers, but not teetotal teaching. Especially the risks to unhealthy and nervous constitutions should be pointed out. It seems to me that twenty lessons a year would be overdoing the subject. No class of men are so apt to use opium, cocaine, chloral, chloroform, etc., and poison themselves thereby, as medical students and young doctors, who know best their risks and dangers. Knowledge and self-control, like "knowledge and wisdom," far from being one, have ofttimes no connection.

Sir MICHAEL FOSTER, Cambridge, England, December 15, 1897.

I have now received your circular of September 18, and can now write more to the point.

1. I give very little space to the question of alcohol in my Text-Book, because our evidence as to its action is so meagre, and in part so unsatisfactory, that it cannot be dealt with in the more or less dogmatic manner in which I treat all topics in my Text-Book. If I were to say more than I do say I should have to go into a detailed discussion, which would be quite out of place in my Text-Book.

2. With some reluctance Shore and I have added a brief statement about alcohol as a part of diet in the second (American) edition of Foster and Shore. Since I have not a copy of this by me, I cannot call to mind what we do say. But I have no hesitation in stating that in my opinion it is perfectly absurd to devote any large space to a discussion of the physiological effects of alcohol in an elementary work, or indeed in any other than a quite advanced or special treatise. The physiology of alcohol is most difficult, and the little exact knowledge which we possess can only safely be expounded to those who have a real knowledge of physiology. The guide to the use of or abstinence from alcohol is still, and must for a long time be, not physiology but common experience.

The food of man as of other animals consists of two classes

of material. In the one class the material contains potential energy, produces in the body actual energy, and is used for that purpose. So large a part of food is material of this class that this part alone is often spoken of as food. In the other class the material is of value, not because it supplies energy, but because it intervenes in the processes by which the energy present in the first class of material is set free, and, so to speak, directs the setting free of energy. This second class is no less necessary for the well being and indeed the life of the body than is the first. Some kinds of this material, such as water, sodium chloride, etc., possess no potential energy; other substances of this class, which are present in all kinds of food, such as animal and vegetable, so-called "extractives," may contain a small amount of potential energy, but the value of these latter does not depend upon their energy being added to the sum of energy available for the use of the body; they are of use because, like the material devoid of energy, they by their properties direct and govern the metabolic processes of the body.

The substances of the second class play a physiological part in the working of the body, of the same kind as that of the so-called drugs; the one distinction between the two, as between the action, for instance, of sodium chloride and morphia, is that the former in a certain quantity is necessary or of advantage under all ordinary circumstances of the body, in what we are accustomed to call health, whereas the latter is of advantage in abnormal circumstances only, in what we call illness or disease.

It follows from the nature of the part played by the second class of food material that their value to the body is directly dependent on the quantity taken. In the case of each one of them, the proper action of the substance depends on a certain quantity being present in the tissues at one time. If too little or too much be present the metabolic processes are disarranged. Thus if too little sodium chloride be taken per diem the body suffers; if too much be taken the body also suffers, the excess acts as what is called a "poison." And the same is the case with even water. The limit as regards quantity, beyond which the excess produces palpable injurious effects, becomes palpably poisonous, varies of course with different substances. A very great excess of water is needed to develop poisonous effects.

but a very moderate excess of a potash salt readily develops them.

Alcohol belongs to the second class of food material. Though it does contain potential energy, and indeed a relatively large amount, and though within the body it does yield up that energy and thus adds to the sum of actual energy of the body, this is not its important action when taken as part of food. Its value depends not on its being used as a substitute for an isodynamic quantity of starch or fat, but on its directing and modifying the metabolic processes of the body.

Our knowledge of the exact manner in which the food material of the second class intervenes in the metabolic processes of the body is exceedingly scanty. Similarly, though we have accumulated a large amount of information about the "action" of drugs and poisons in large doses, that is, in doses which produce obvious physiological effects, we know very little about the exact way in which doses of these substances which do not produce obvious "symptoms" affect the body. Our knowledge of the action of alcohol is at the present time in the same condition. We know something of the physiological effects of large, that is to say, poisonous doses, but we know very little concerning the exact physiological effects of doses of alcohol which produce no immediate palpable effects, in other words, of alcohol as an article of diet. The investigation of the problems connected therewith are extremely difficult and complex. For instance, the question: Does alcohol aid digestion or the reverse? cannot, so far as I know, be answered physiologically at the present moment. Observations have been made as to whether the addition of alcohol (in such a dose as when taken by an individual would produce no decided obvious symptoms) to an artificial digestion mixture influences the digestion; but these observations, whether they show retardation or acceleration of digestion, or neither, are not to the point. The effect of alcohol taken with food is not limited to its action on mixtures within the stomach; it may, and probably does, affect the whole act of digestion in many ways, some of them perhaps very indirect; it may act on the secreting or absorbing mechanism of the stomach; it may act on the vaso-motor system, and so on. Concerning all this our knowledge is at present insufficient.

Hence it appears to me that no distinct physiological dicta

concerning the usefulness or the opposite of alcohol as an article of diet can at present be enunciated. Any physiological opinion which may be given is of less value than the teachings of general experience. What physiology can state is that if a number of persons say that a certain quantity of alcohol per diem seems to them to be a means of keeping them in health and vigor, there is nothing in our present knowledge of physiology to lead one to doubt the validity of the conclusions thus drawn from experience. The fact that alcohol taken in a certain quantity is obviously injurious is no argument whatever against a smaller quantity being beneficial, the exact limit varying with individual features and various circumstances, for this dependence of the nature of the effect upon the quantity is, as has been said, characteristic of food material of this class. Since we do not know the details of the action of alcohol, we cannot explain why it seems in the case of certain persons to be advantageous: nor can we explain why A seems perfectly well without any alcohol at all, and B seems equally well with a certain quantity taken every day. So long as we are ignorant of the details of the action there is no reason why we should think B mistaken and A correct.

Professor ARTHUR GAMGEE, Montreux, November 15, 1898.

The statement which you have sent me precisely expresses my opinion on the subject of the use of alcohol. I have on several occasions abstained from alcohol during a period of some weeks, and have found that my working capacity was thereby injuriously affected. The assertion that alcohol does not supply energy to the body is, as every one must admit, disproved by the experimental facts in our possession, and it must be admitted by all physiologists whose judgment is not tainted by blind prejudice that alcohol must, therefore, be classed among the articles of food. The only question which remains to be discussed is, therefore, whether it is a safe or expedient article of food. Subject to limitations as to amount and manner of consumption, it appears to me that alcohol is a valuable constituent of the diet of man; and personally I have no doubt whatever that a physician cannot properly discharge his duties towards his sick patients if he systematically and uniformly eliminates alcohol from their diet.

Professor W. D. HALLIBURTON, London, October 20, 1897.

I have received your letter of the 18th ult. *re* the alcohol question. My students are in the main medical ones, and I consider a brief statement on the subject, such as is contained in my text-books, is all that is necessary in lecturing to them. They have the subject much more fully set out in their lectures on Pharmacology, and can see for themselves the ill effects of excess in drink in the hospital wards during their clinical studies.

I consider the large amount of space that Bunge devotes to the subject uncalled for. Bunge, however, is an enthusiast on this special question, and his statements have the bias usually seen in enthusiasts.

With regard to lectures to elementary teachers, it is perhaps necessary that the evil effects of alcohol should be dealt with at somewhat greater fullness, as they have to teach a mixture of Hygiene and Physiology in their so-called Physiology classes. The proposal to devote a fifth of the text-books to the subject is to me preposterous. One might with equal justice devote another fifth to the opium question, another fifth to hashish, and I dare say one can find two other drugs to fill in the remaining two fifths, and thus exclude all useful physiological teaching. If teetotal propaganda form part of a child's instruction it should be labeled as such, and not called Physiology.

Sir J. BURDON SANDERSON, Bart., Oxford, November 22, 1898.

The statement about alcohol that you send me in an amended form so exactly expresses what I think, and should like, if the opportunity offered, to say, that I do not wish to add anything to it. I myself often experience the advantage of alcohol, and the more the older I become. I have also experienced the horror of an overdose, particularly when experimenting with whiskey in association with the late Dr. Anstie. I can think of nothing more disagreeable than the effort to make observations on one's self when half poisoned. But I quite agree with you that, notwithstanding, alcohol is *not* a poison, as well as with your definition of a poison as a thing which can only do harm and never good.

Professor E. A. Schäfer, London, October 22, 1897.

In reply to your queries I beg to state that the alcohol question is hardly touched upon in my course of Physiology: it is, I believe, treated in the course of Pharmacology. Beyond incidental references to its effect in large doses in reducing temperature and its value (?) as an article of diet, I do not deal with it.

Personally, I do not doubt that it would be useful to insist, in elementary courses of instruction intended for the laity, upon the deleterious effects of over-indulgence in alcoholic drinks. Whether this would tend to increase or diminish abuse of alcoholic drinks can only be determined by careful statistics, and one's individual opinion is of little or no value: to assume the possibility of such instruction *increasing* their abuse seems to indicate a very definite belief in the asinine qualities of human nature. I should at least *hope* that the effect might be to diminish their abuse.

Professor P. H. Pye-Smith, London.

I have signed the statement you sent me, and return it to you. One must assent to the general sense of such documents, for every man would use different phrases. The definition of a poison is not quite satisfactory. Arsenic and strychnine would be excluded, for they sometimes do good. Truly, everything depends upon the how, when, and in what dose. The value of alcohol as a food is in most cases small, and chiefly seen in illness when no other food can be absorbed. But its dietetic value depends, like that of mustard, pepper, vinegar, tea, coffee (and tobacco), upon its sedative effect on the nervous system, and its stimulating effect on the glandular system, as well as on its effect on the heart and cutaneous vessels.

Physiology as an experimental science not only has not, but I think never will decide whether the moderate use of alcoholics is good or bad. For many, perhaps for most, it is (physiologically) indifferent. But science can say it is (by definition) a food, oxidized and so contributing energy, and it is not (so taken) a poison, i. e., injurious to health.

Personally, I have a strong conviction that diluted spirits do more harm than good, and are only desirable in old age or in

special cases, while wines and malt liquors for a large number (perhaps for most adults), when taken with meals, do more good than harm. The practice (or fashion) of ordering all dyspeptics to take whiskey and water with meals (for which I am afraid the late Dr. Andrew Clark was to some extent responsible) is to my mind a bad one.

Temperance is much better than abstinence, and in England we are certainly far more temperate than our grandfathers, as temperate as we were in the seventeenth century or in the Middle Ages. I am afraid in France intemperance is more common than it used to be. With us spirit-drinking is worse, I believe, in Glasgow and some of the Scottish towns and in our Colonies, particularly the Cape and Australia. I have never seen a drunkard, or one inclined thereto, among my American patients, and do not remember to have seen intemperance (with one exception) in the United States.

CONTINENTAL AUTHORITIES.

Dr. A. Baer, Penitentiary, Plötzensee, near Berlin. Professors G. v. Bunge, Basel: A. Dastre, Paris: J. Dogiel, Kasan; J. R. Ewald, Strassburg: S. Exner, Vienna: A. Fick, Würzburg; A. Forel, Zürich: J. Gaule, Zürich: P. Heger, Brussels: H. Kronecker, Bern; W. Kühne, Heidelberg; Ch. Richet, Paris; C. v. Voit, Munich.

Dr. A. Baer, Berlin, November 26, 1897. (Translation.)

. . . .

Concerning the most important question, whether I agree with the sentiment in the newspaper clipping which you sent me — which I herewith inclose and acknowledge as my own view — I am ready to answer in the affirmative in the fullest degree. According to the prevailing opinion of the great majority of our experts, which is based upon the results of physiological experimentation and the observation of healthy as well as sick people, the facts in the approved and indorsed school-books on hygiene and physiology can be considered as the expression of modern science, in so far as they bear upon the use of alcoholic drinks. With us as with you, now and then a voice is raised in favor of the opposite view: this cannot, however, greatly modify the above-mentioned opinion. In all ques-

tions that come under scientific discussion there are dissenting and modifying views, but through them all there runs an underlying opinion from which very few of the scientists differ; and I believe I am not wrong in pointing out the statements in the letter which I have addressed to Mrs. Hunt as an opinion of this sort.

The second question is whether I would recommend the introduction of this method of instruction into our schools in Germany. The manner and method of instruction on this question must of necessity accommodate themselves to the system of public instruction in general. If an instruction in this direction could be given, I would have exactly the same things taught which are regarded as the essential things in the books above referred to. Moreover, with us it is regarded by the advocates of temperance as a very effective and justifiable method of work to acquaint the school-children with the true facts regarding the value, use, and abuse of alcohol, i. e., of all alcoholic drinks. As the government and the school management have not thought yet of introducing such an official instruction, we have ourselves tried to come into relation with the teachers in a private way, and to give them instruction in this direction. Although we have not yet accomplished a great deal, our efforts are everywhere openly recognized by the highest school authorities. Here in Berlin we are now trying to work out this principle in the form of health regulations, and to spread them among the school-children. I had hoped to be able to send you these rules, but unfortunately they are not yet ready.

I cannot regard it as an argument against this sort of instruction that the child, when thus taught in the school, may come into conflict with the lives of his parents. According to this pedagogical principle, one must not teach in the schools the fundamental doctrines of morality and religion, such as the decalogue and so forth, because unfortunately in many families these are actually and openly sinned against. Many children are said, as you allege, to be led to a liking for alcoholic drinks through this instruction. If such is actually the case, it is caused, in my opinion, only by a bad sort of instruction and by a very unfortunate method which the teacher himself chooses to employ. Only when the teacher, in the interest of truth and public welfare, puts this branch of instruction earnestly and

worthily before the young and makes it intelligible to them, can his work be successful in the highest sense. There is but one truth which the instructor can teach. If he is opposed to this principle and shows this opposition in his method of instruction, then he must do more harm than good.

From a very thorough study of that excellent book, "The Liquor Problem, its Legislative Aspects, by the Committee of Fifty, 1897," I have seen how strongly legislation on the alcohol question has been influenced by politics and party conflict. Must not the party platform also influence the teacher, and through this make itself felt even in the instruction?

An impassionate, earnest, sensible teaching of these subjects, a truthful, rational instruction of the young about these facts, cannot possibly lead to an increase in the consumption of alcohol. It can cause a decrease in the same only after generations; but the youth of the present day can be urged along the road to drink only when the instruction is imparted not in the highest sense of an honest love for truth, but in quite the contrary spirit.

Instruction on this question is already given in Belgium, Holland, and England. An effort is being made to introduce it in France, Germany, and Austria. Nowhere has such a criticism been made against this means of fighting alcohol. Were it possible that this great evil should arise, — granted that the method of instruction is the right one, — then I would be among the first to banish the instruction from the schools. At present an effect of this sort appears to me hardly possible.[1]

[1] Additional Testimony that the Indorsed Temperance Physiologies are Accurate; from the Royal Sanitary Commissioner in Berlin, Germany. — Dr. Baer, the foremost European specialist on the subject treated in these text-books, has recently subjected these same books to a rigid examination. We give below the result of his investigations: —

Berlin, N. W., May 15, Rathenower str. 5.

National and International Department of Scientific Temperance Instruction in Schools and Colleges, represented by Mrs. Mary H. Hunt, Superintendent, 23 Trull Street, Boston, Mass. Honored Madam, — By your letter of March 15 you have done me the honor to request my opinion in regard to the "approved and indorsed temperance physiologies" which have been sent me, and are now in use in the public schools of most of the States of North America, as to whether the teachings of these school books, in regard to the value and effect of alcohol and of alcoholic drinks, are in harmony with the principles of modern science.

Professor G. von Bunge, Basel, October 22, 1897. (Translation.)

Accept my grateful thanks for the esteemed invitation to share in the work of your Committee. As you write me that you are in possession of my text-book (edition III., 1894) I have nothing essential to add to what is therein expressed, and so send you my further publications upon the alcohol question.

As to the second question, I consider instruction in the schools upon the alcohol question certainly very desirable. It is important to overcome prevailing prejudices before it is too late, that is, before the young people have become slaves to alcohol. The number of such slaves is greater than is generally believed. It is a fatal mistake to suppose that slaves to alcohol are only those who lie in the gutters. There are numberless men who always drink one moderate glass. To this moderate glass, however, they cling quite as inveterately as the morphinist to his syringe. These men are, and remain, the unrelenting enemies of the abstinence movement.

With regard to the number of hours, 250 hours seem to me to be a great deal certainly, yet I do not presume to contradict experienced abstinence leaders. We ought not to forget how many more hours the contrary is brought before the young.

In order to ascertain the truth of the important question at issue, I have gladly undertaken the task, and have examined with strict impartiality the school books sent me [enumerating the text-books on the indorsed list].

On the basis of the examination I have made, I can assert that the above-mentioned school text-books, in respect to their statements regarding alcoholic drinks, contain and disseminate no teachings which are not in harmony with the attitude of strict science. Ideas and facts as to the actual value of alcohol as a food, as to the effect of its occasional or habitual use upon the body, upon the tissues and organs, likewise upon the brain and its activity, are throughout represented correctly and clearly, and often with remarkable felicity adapted to the youthful understanding.

Though personally I do not practice total abstinence, yet I consider the dissemination of the above teachings in the way of instruction in the schools wise and the most admirable and effective means of opposing and averting the serious evils which alcohol does both the individual and society, and of bringing about a complete change in the drink habits.

Hoping for the best results of your efforts, I remain with much esteem, your obedient servant, Dr. A. Baer, Geheimer Sanitätsrath, Chief Physician of the Penitentiary, Plötzensee, bei Berlin. — *The Union Signal* of the National W. C. T. U., Chicago, July 15, 1897.

More depends on the teacher, in my opinion, than upon the number of hours. But more important than all teaching is example. *Verba docent, exampla trahunt.* Children are fine psychologists; they pay little attention to what is said, but notice exactly what is done.

Please remember me kindly to all fellow combatants.

Professor A. Dastre, Paris, April 15, 1899. (Translation.)

One can look at the alcohol question from the point of view of hygiene and from the point of view of physiology.

1. From the point of view of hygiene.

I think, with you, that alcohol, taken in small and reasonable doses, in the form of good wine, with meals, is an excellent thing, very agreeable, and entirely harmless. *Bonum vinum lœtificat cor hominum.*

But an excessive amount, its abuse between meals, its ingestion in concentrated form, are harmful. One should not drink alcoholic liquors on an empty stomach or in excess.

This is what we nearly all of us think in our country of France, which still produces some very good wines, rejoicing, strengthening, and comforting *cor hominum.* There are very few teetotalers among us. It is a rare species.

2. From the physiological point of view.

I believe that alcohol is preëminently a nervous stimulant, that it is not, properly speaking, a food.

Why do I hold this opinion? For theoretical and for practical reasons.

When alcohol is ingested it is divided into three parts: —

1st. About $\frac{1}{10}$ is fixed in the anatomical elements (Lallemand Perrin, Duroy, Rabuteau, etc.).

2d. $\frac{n}{10}$ (n, variable, unknown) is eliminated by the respiration and by the emunctories.

3d. $\frac{n}{10}$ is oxidized in the circulating blood and produces heat.

Alcohol is then *thermogenetic* (1 gram is thermogenetically equal 1.66 gram of sugar, 1.44 gram of albumen, or 0.73 gram of fat). Most physiologists say: it is thermogenetic; it is therefore a *food*; it is *useful*.

This reasoning is false in theory and in fact.

I. It is false in theory.

To understand this it is necessary to go back to first princi-

ples and to inquire what is the function of heat in connection with vital processes.

Heat is condition of the medium, nothing more. The modern conception of biological energy shows that this condition may be *useful*, *harmful*, or *indifferent* according to circumstances; that it is not always useful.

. . . .

Heat is an excretion.

There are two types of *thermogenetic* foods.

1. Bio-thermogens, true foods, carbohydrates, albumens, and fats.

2. Pure thermogens, false foods. Alcohol is a pure thermogen. It circulates with the blood. Only a tenth part, fixing itself in the anatomical elements, is a bio-thermogen, i. e., a true food.

II. It is false in fact.

The experiments of many authors, particularly Hammreich and Miura (my own have confirmed theirs), have shown that alcohol is not isodynamic with the carbohydrates. My own experiments have been principally upon malic, citric, and tartaric acids, which, with glycerine and alcohol, form a group — the *pure thermogens.*

I know as well as any one the difficulties of these experiments and the numerous sources of error to which they are subject. There are some physiologists, and among them perhaps your compatriot Dr. Atwater, who have obtained different results.

It is for this reason that the agreement between theory and experiment has here a great value. I have greater confidence in the results of my own experiments and of those of Miura because they are in harmony with these theoretical views. It is not a case of absolute demonstration, but of a strong presumption.

Professor J. Dogiel, Kasan, December 18, 1897. (Translation.)

You and Dr. Hodge have expressed the wish to learn my opinion upon the physiological importance of alcohol as a nutriment, as a relish, and as a remedy; furthermore, upon the advantages which may be expected as a result of introducing the teaching of the physiology of alcohol into the schools.

From my researches, which were undertaken principally for the purpose of investigating the physiological effect of spirits of wine, and which have been published at different times, I have reached the following conclusions: —

1st. The monotomic, saturated alcohols of the fat series have an essentially similar effect. The difference between them consists only in the intensity of their effect, which is dependent upon the number of the CH_2 group in their composition, so that methyl-alcohol (CH_4O) can be regarded as the weakest, and amyl-alcohol ($C_5H_{12}O$) as the strongest, of the five first alcohols in this series.

2d. Ethyl-alcohol, or the spirituous drinks containing it, exercises a strong effect upon the animal organism and changes the physiological action of the organs of digestion and of circulation, of the nerve and muscle system, of the organs of secretion and excretion, and of respiration, into a pathological activity.

3d. Ethyl-alcohol can be regarded neither as a useful stimulant nor as a food material.

4th. If strong (ninety per cent.) or diluted (thirty per cent.) ethyl-alcohol can in certain cases be useful as a medicine, it nevertheless cannot be regarded as an indispensable remedy.

5th. Alcohol and spirituous drinks effect no heating of the body, but rather a cooling off.

6th. Muscular action is not increased, but is decreased, by alcohol and spirituous drinks.

7th. The effect of alcohol upon the heart, the distribution of blood, the rapidity of flow, and the formation of the blood, is shown as follows: in acceleration of the heart-action with gradual decrease of contractility on account of the change in structure, fatty degeneration of muscle in this organ, through the continual use of spirituous drinks: in the retarding of the blood-flow and decrease of blood-pressure, which depends on a change of structure of the blood vessels and on a similar change of the nerve elements of the brain, spinal cord, and heart. The composition of the blood undergoes a change under the influence of ethyl-alcohol which makes itself evident in the disturbed gas exchange in the organs, and in changes of the respiration.

8th. A structural change doubtless also takes place in the nerve-cells of the heart, of the retina, and of the brain, as a consequence of the continued effect of ethyl-alcohol.

The diminution of the visual power caused by alcohol appears in both eyes at once and with equal strength. With this is noticed a peculiar characteristic affection of color-perception for red and green light: all objects of these colors seem more or less intensely gray. This change in color-perception is one of the first symptoms of alcohol-poisoning: a further symptom of such an affection is the weakening of the power of accommodation.

In animals the influence of ethyl and amyl-alcohol upon the retina is shown in the degeneration of the nerve-fibres.

9th. Spirituous drinks predispose mankind to various illnesses.

10th. The use of spirits appears from a social and moral point to be extremely momentous. It lays the foundation for pauperism, insanity, and various crimes.

11th. A decidedly restricted sale of spirits, the prosecution of adulteration, the founding of hospitals for the care of alcohol-victims, — all these are desirable and certainly useful, but cannot hinder the development of the propensity to use spirituous drinks.

12th. The effort to check the propensity to the use of alcohol, to root out the passion for drink, is most assuredly no Utopian project. It lies within the limits of possibility. The inner consciousness provides the only means to this end, — a firm will, a strong character, — and is maintained only through a correctly guided education from earliest childhood.

13th. There can be no doubt about the influence of parents and the educators of youth upon the development of character and will.

14th. An intelligent teaching of the injurious effect of alcohol introduced in the schools would be very desirable and extremely advantageous; indeed, therein lies the only way by which the development of the inclination for the use of alcohol can be combated.

15th. Such instruction as to the terrible effects of spirituous drinks could be given to young children by intelligent, cultivated women: to youths of somewhat riper years by experienced pedagogues and persons who have made a specialty of researches into the physiological action of alcohol and spirituous drinks.

16th. As means for the forming as well as the improvement of character, and as most important influences against the habitual use of spirituous drinks, the following agencies deserve consideration: music, singing, various games and excursions, and finally traveling, — because these offer an entire diversion, acquaint one with his country, and with nature, etc.

Inclosed I send you my article in Russian, "Spirituous Drinks as Predisposing Sources of Various Illnesses of Mankind." This has been recommended by our clergy for the libraries of the middle-grade schools, seminaries, and institutes. I send you also my research "On the Influence of Music upon Men and Animals," in Russian.

J. RICH. EWALD, Strassburg, December 13, 1898. (Translation.)

The circular which you so kindly sent me contained nothing at variance with my opinion, and I would gladly have pleased you by signing it if I were not on principle in favor of the most stringent restrictions upon alcohol-drinking. Certainly, in small doses, alcohol is not harmful, but, as experience teaches, it very rarely stops at these small quantities, and we daily see the saddest consequences of excessive drinking of alcohol. Because temperance is scoffed at, much drinking and drinking too much will be encouraged in every way, and in a certain sense will be rewarded. Since, therefore, a reaction against alcohol has at last set in, and the state, as well as society, is making a move against alcohol, it seems to me that this is an extraordinarily important advance from an ethical as well as purely practical point of view, and I would like to see it encouraged under all circumstances, even at the risk of overstepping the mark in the first zeal and of giving up the small advantages which, under certain circumstances, alcohol may possess.

Professor SIGM. EXNER, Vienna, November 23, 1898. (Translation.)

As you see, I have signed your circular. I should have been more in sympathy with it, however, if the suggestion of using alcohol as a nutriment had been left out. For this purpose it is too expensive (combustion warmth in comparison with that of the material from which it is made) and too dangerous. Aside from this, I am in entire sympathy with your undertaking.

A. FICK, Würzburg, November 3, 1897. (Translation.)

From your valued letter dated October 4, 1897, I see that you have my little article upon the alcohol question. I know nothing essential to add to what is therein said with regard to the physiological action of alcohol. A publication of Ziehen's on the action of alcohol came to my notice a short time ago, but as it is not at hand just at this moment, I cannot give an exact reply to it. However, in Ziehen's article, as nearly as I can remember, not a single indisputable argument for the usefulness of alcohol is brought forward. At most, I could agree with Ziehen that alcohol in the smallest possible amounts is not harmful to the health. Upon this subject I have already expressed my views in my report on the alcohol question.

In the mean time, there has also appeared an investigation by Frey in Bern, which is much discussed, and in which he claims that alcohol will strengthen fatigued muscle. It is my conviction that the apparent strengthening in Frey's experiments rests entirely on suggestion, of the powerful effect of which I have convinced myself in similar experiments.

To your second question I have to answer that I consider instruction upon the effects of alcohol very advantageous. I believe that this instruction must lay special stress upon the undeniable truth that alcohol is under no conditions and in no amount beneficial to the healthy body. Whether alcohol can act beneficially under morbid conditions of the body I do not consider proven. Naturally, I cannot pass judgment upon this question from my own experience.

Professor A. FOREL, Burghölzli, October 25, 1897. (Translation.)

In my opinion the question of the value of alcohol as nourishment, stimulant, and particularly as part of the human diet, has been completely settled. Alcohol is a poison and not a food. Its claim to be of value in economizing the use of other food has been refuted thoroughly by Dr. Miura in von Noorden's laboratory. But, even if there were anything in this idea, to the unbiased man of science it must be obvious that a substance which in large doses causes such frightful toxic phenomena in all the organs as does alcohol (brain, liver, heart, etc.) excites the gravest suspicion that when, in small doses, it

diminishes proteid metabolism, it does this at the cost of the normal functions and normal structure of our tissue. When one considers objectively, and without prejudice, the ravages caused by alcohol-drinking, in the way of crime, death, suicide, physical and mental illnesses, hereditary malformations and degeneracies, it seems utterly insane that humanity could use such a substance as an article of food and a relish. This only goes to prove that the primitive man, like the higher forms of monkey and pithecanthropi, was on the one hand excessively inquisitive and on the other hand quite scientific. They discovered fermentation, experimented with fermented liquors, found their narcotic properties agreeable, and, without further thought, the habit of alcohol-drinking was adopted and confirmed in the course of centuries. So long as the knowledge of primitive men taught them to produce fermented drinks only in small quantities, and did not show them how to store these products in large amounts, the evil remained comparatively localized, and could not threaten the progress of humanity, as it does to-day, when alcohol, produced in a thousand ways and extremely cheaply, brings in question the endurance of our race on the earth.

The prejudice maintained for centuries through poetry, mythology, religion, and history has rooted itself so deeply that it blinds men, and, unfortunately, medicine and science are also held captive by this prejudice.

It is with this as it was with the prejudice in favor of slavery in your country fifty years ago. This explains the tremendous difficulty in obtaining scientific moderation in judging the question of the use of alcohol. You would ridicule me if I should put the question to you in all earnestness if we ought not to introduce arsenic, atropia, or codeine as food or stimulant or relish in our daily diet, and yet scientifically regarded and used in dilute doses it comes to the same thing. I especially recommend to you the study of the recent experiments of Smith-Führer, Aschaffenburg, and others in the laboratory of Professor Kraepelin at Heidelberg, upon the effect of small doses of alcohol on the mental activity, as well as those of Professor Destree (professor in the University at Brussels, rue de la Regence 41) upon the effect of alcohol on muscle-strength. From all these experiments it is clear that alcohol — in small

as well as in large doses — paralyzes and disturbs the activity of the muscles as well as the concentration and the correctness of thought. Even 7–10 gr. is sufficient for this, and a certain brief stimulation of the motor apparatus is to be regarded as a reflex phenomenon due to nerve injury and not as an indication of increased power. I advise you to get the book by Destree as well as the Heidelberg works.

You will not require me to describe alcoholic psychoses, alcoholic fatty heart, liver cirrhosis, — every physician understands them sufficiently: allow me to say, however, that the social effect of wine and of beer, the mental enjoyment of society, is nothing else than intoxication of the brain. Through pure prejudice this is commonly forgotten, and yet it is quite obvious.

I hardly know what points should be mentioned as "not yet sufficiently determined." The defenders of alcohol-drinking are not in a position to state a single reasonable ground which could be maintained against a serious scientific criticism. Their whole argument rests upon fashion and public opinion. I recapitulate my views in the words that alcohol in all forms and doses is a poisonous substance which disturbs the human organism and its functions, is extremely dangerous and injurious to individuals and to society, possesses not the slightest usefulness, and therefore should be absolutely excluded from human diet.

Of course it is quite a different thing with regard to the use of alcohol as a medicine, for we have the right to temporarily employ poisons. Still, even here a monstrous abuse is practiced, and the indications for the use of alcohol are very limited: it almost never happens that I use it, for even a stimulating effect is problematical to my mind, because it is followed much too quickly by paralysis and depression.

It goes without saying that alcohol is very useful in the arts as a preserving medium; this question, however, does not come into consideration.

For the sake of simplicity I send you with this letter in a newspaper wrapper my point of view and that of my colleagues as expressed in some extracts from the "International Monatschrift zur Bekämpfung der Trinksitten," published on the occasion of the founding of our German Temperance Medical Association. From these you can see our point of view still more clearly.

The second question is more difficult for me to answer because, unfortunately, central Europe is still inexperienced in this matter, and it is not scientific to theorize *a priori* upon matters which have not yet been tested. It seems to us urgently necessary that temperance shall begin in youth, for it is much easier not to take up a bad habit than it is to free one's self from an old habit. On that account we are very much in favor of total abstinence societies for the young, and up to the present time have had very good results. Mr. Denis has written a temperance manual for our youth (for sale at the agency of the Blue Cross in Bern) which seems to me very good. I think it is necessary that the young should be thoroughly informed about this terrible destroyer of nations. On the other hand, it appears to me injudicious in treating of other sciences, such as anatomy and physiology, to treat these sciences from an anti-alcoholic standpoint. One ought as little to teach a religious or catholic anatomy or physiology, as to drag the anti-alcohol movement in where it has nothing to do with the subject. I think that in this respect in America somewhat unwise methods have been adopted. It is only in connection with hygiene and chemical physiology that an energetic chapter on alcohol should be introduced, warning against the use of alcohol and stating clearly and scientifically the arguments for this point of view. I believe, so far as I can judge without any practical experience, that this would be the right way to instruct the young on this subject. My humble opinion is therefore briefly this: an anti-alcohol instruction is at this time needed, but this should not be connected with the other subjects of instruction except in so far as the alcohol question belongs to them.

I hope, honored colleague, that I have conscientiously answered your questions according to the best knowledge. For me there is only one way to obviate the alcohol misery, and that is the complete withdrawal from human diet of all drinks containing alcohol.

Professor J. GAULE, Pegli, near Genoa, October 27, 1897.
(Translation.)

I am greatly pleased with the intention of the Committee of Fifty to obtain the opinions of physiologists on alcohol, and am

very glad to express my own. I value alcohol neither as a food nor as a relish. As a nutriment the calories contained in it cost too much and it has too many disagreeable results. Besides, it is possible, as the works of Rubner and Miura seem to prove, that this heat-production causes exactly the same amount of outgo as of income in the organism, and so no advantage is gained. Alcohol is not to be considered as a relish because it has very disagreeable after effects upon the organic cells. In this connection former observations are to be brought into prominence, — upon the production of catarrh of the bowels, affections of the liver, and of the central nervous system. Not less important are the more recent views upon the condition of the organs of circulation, resulting from excessive drinking of diluted alcohol (Munich Bier), the changes of the individual cells, particularly the germ cells, as brought to our knowledge by Raffael Dubois, and the influence of alcohol upon living cells (Overton). We must also pay attention to the influence of alcohol upon the rapidity of the various reactions of the nervous system as investigated by Smith and Führer in Kraepelin's Laboratory, and to the plasticity of the entire nervous system under the influence of small regular doses during growth, investigated by Hodge and others. These should all be brought to the knowledge of the growing generation. I must decline to speak of alcohol as a means of cure, as medicine, for that lies beyond my province as a physiologist. I must also say that I do not know at what age one can best begin to teach young people about alcohol. For that, the experience of a public school-teacher is necessary, and I do not possess this. It seems to me, however, that one must be careful not to produce a surfeit of this theme.

Professor PAUL HEGER, Brussels, December 24, 1898. (Translation.)

I am sending you with this letter three copies of the syllabus of a popular course I have given this year. You will find on page 22 and in what follows the exact expression of my thought relative to the question on the subject of which you have desired my opinion.

"It would be wrong to exclude beer and wine from a dietary under the pretext that these drinks contain alcohol: it is a well observed fact that alcoholism makes less ravages in countries.

such as Norway, where the consumption of beer is very widespread, or Italy, which produces a great deal of wine, than in countries like ours, where alcohol is furnished cheaply to the poorer classes.

"That which makes it necessary to prohibit anything is its abuse. With regard to alcohol and strong alcoholic drinks, it is necessary to absolutely prohibit them from food: the nutritive properties of alcohol are very uncertain, while the intoxicant properties are very evident."

I agree entirely with the opinion of those physiologists who refuse to interdict the use of beer or wine: to prohibit beer because it contains a small dose of a poison which is called alcohol would lead us in the name of pitiless logic to also prohibit tea because it contains a certain amount of poison, théine; to prohibit coffee, which contains caféine; to prohibit even meat itself, which undeniably contains organic poisons.

I only regret that the statement which you have submitted to me does not affirm at the same time the harmlessness of drinks containing small proportions of alcohol and the harmfulness of strong alcoholic drinks. Pure alcohol is injurious; alcoholism is a horrible evil. I would like this not to be forgotten when anything on this subject is said in the name of physiology.

It is in these terms and with this sole reservation that I send you the expression of my assent.

Professor H. Kronecker, Bern. (Translation.)

. . . .

I have still to thank you for your October letter in which, on behalf of the Committee of Fifty, you desire to know my experience and view with regard to the influence of alcohol on the animal organism.

You have the two works on this subject which were done under my direction: —

In that of McGregor Robertson, "On the Effect of Ether on the Heart of the Frog" (Verhandlung der Physiol. Gesellschaft, Berlin, March, 1881, reprinted in du Bois-Reymond's Archiv of 1881) we furnished, in the essentials, the demonstration, which I believe important for the alcohol question, that the concentration, not the absolute quantity, of the ether determines

its action. A one per cent. solution (in the blood) has always a stimulating action upon the frog's heart (increasing the frequency of pulsation): a two per cent. solution has a paralyzing effect even at the beginning of its action.

. . . .

In connection with given doses of alcohol whose effect upon vegetable and animal life of dogs Hodge has investigated with so much patience and skill, it would be interesting to consider also the degree of dilution in which the alcohol is administered. Hodge says (p. 11 of his excellent paper), "6 c. c. alcohol in 40% solution, and *mixed with their breakfast.*" This causes an additional dilution of uncertain amount. I remember very well in my student days at Leipzig that the "early cup"[1] is the most dangerous, while the συμπόσιον after the δεῖπνον, as was customary among the Greeks, does not as easily intoxicate. Therefore the unadulterated light wines of 6–8% alcohol can be taken in large amounts, while Italian, Spanish, and Greek wines, containing 20–21% of spirit, come nearer to the distilled liquors of 30–50% alcohol. The harmful effect of Bavarian beer, which contains only 3–5% alcohol (Heidelberg beer scarcely 2%) is really chiefly due to the quantity of liquid with which the body is filled.

Oertel and Schwenninger (Bismarck's physician) have indeed made wonderful cures by stopping the drinking of water. Milk is also considered dangerous in these days (Rumpf) in diseases of the circulatory system because it contains too much water and lime. I believe that the pernicious effects of alcohol proceed more from the substances mixed with it (absinthe, fusel oil, etc.), and from the immoderate drinking of concentrated solutions in badly ventilated rooms where frequently the entire atmosphere is saturated with alcohol fumes and tobacco smoke.

. . . .

It has filled me with astonishment that the movement against alcohol drinking could assume such large proportions amongst your nation, — which is free from prejudice. I was quite shocked when I read in Hodge's letter (of September 28) which he wrote at the request of the Committee of Fifty, that in the primary and middle grades every child from six to seventeen

[1] That is, alcohol on a comparatively empty stomach.

years is instructed 250 hours in the physiology of alcohol. If I were to teach this subject five hours I should know of nothing more to say and should probably be discharged by the authorities as a stupid teacher.

. . . .

I consider that such narrow-minded methods of combat breed fanaticism. Wine-drinking is forbidden among the Mohammedans, and the Arabs have shown unquestionable moral virtue, bravery, shrewdness, inventive skill in technique, art, and science, but they have been utterly beaten at every point by the wine-drinking nations of the West.

What great things have our apostles of abstinence accomplished in comparison with the great friends of wine such as Byron, Goethe, Bismarck? Helmholz and Ludwig were also friends of a good drop.

The Mohammedans make up for their deprivation of wine by the use of haschish and opium. Modern abstainers would take up morphine injections, cocaine, and other excitants, whereby manufacturers of chemicals would gladly enrich themselves at the expense of the vineyard owner and the beer brewer.

Let tobacco be given up, which ruins so many hearts and brains; strong tea and coffee, which contain known poisons; then let the sexual impulse be controlled, — the source of the most blighting diseases and weaknesses; and all the moral errors, — race hatred, party passion, class prejudice, greed, purse-pride, etc. It is not by the prohibition of one or another error, but by the example of model lives that human happiness is to be secured.

Professor W. Kühne, Heidelberg, December 16, 1898. (Translation.)

. . . .

I certainly agree with the first paragraph of the translation of your communication, but not with the second. For according to my view the oxidation of a substance in the animal body does not determine its injurious or its useful effect, just as, inversely, many a substance may be useful to life without contributing directly to the production of kinetic energy. Indeed, I consider the second paragraph dangerous, as you will be understood to consider alcohol as a food and to recommend it as such. . . . If I am, as your letter permits, to express my views on the

alcohol question in my own way, I must base my opinion only upon general experience which I do not find to be contradicted by any physiological or medical facts.

Alcohol is one of the many stimulants or relishes discovered by man accidentally and used by him for ages empirically because without these aids he simply cannot live.

Judging from the bad results obtained from the most nourishing but tasteless prison fare, which, regarded simply as a food mixture is evidently far better than the food of so many free laborers, one cannot doubt that even the most perfect nutrition is insufficient without the assistance of some relish. But all these relishes which are necessary, even if the fare consists principally of meat, are harmful when taken in large doses. This can be affirmed even in the case of common salt and especially of all spices, coffee, tea, tobacco, etc., and yet no race does without them unless indeed for religious reasons, when the one takes the place of the other.

When one sees how many normal, hard-working people arrive at a ripe age while using these stimulants with discretion, among which I include the moderate use of alcohol, one does not find good reasons for total abstinence.

There is only one exception to be made, which, however, applies not only to alcohol but also to other stimulants, i. e., the prohibition of its use to children and to adolescents. Certainly one should oppose the misuse of stimulants, but I do not think that it can be abolished by treating and judging the moderate and immoderate uses alike. Abuse and use are opposites.

Much more could be said on the subject, but I think the preceding will suffice, especially as you will have received many exhaustive treatises from other sources.

Professor Ch. Richet, Paris, France. (Translation.)

In response to your letter here are some points relative to the physiology of alcohol which appear to me well and firmly established: —

1st. The use of alcohol is absolutely pernicious to young children; it is always injurious, but most particularly so for children less than fifteen to eighteen years of age.

2d. It has a bad effect upon the gastric digestion: where alcohol is used there is no more good digestion. People afflicted with dyspepsia have been cured by abstaining from alcohol.

3d. It is believed that it gives strength, but this is a singular illusion. It reduces muscular strength. The most vigorous workmen are those who do not take alcohol.

4th. The least dangerous alcohol is the alcohol of wine (C_2H_6O), or ethyl alcohol. Unadulterated wine (which is very rare) is without much of a disturbing element, though always injurious even in small amounts. All other alcohols contained in alcoholic drinks (whiskey, gin, rum, brandy, kirsch, bitters, vermouth) are very intoxicant; in equal quantity 3, 4, 5, or even 10 times more intoxicant than ethyl alcohol. In wine there are very apt to be these intoxicant alcohols, as alcohol made from grain is added to wine to keep it.

5th. Absinthe is the worst intoxicant of all, one of the most dreadful poisons known. I demonstrate in my course that one can give 500 times more absolute ethyl alcohol, very pure and highly rectified, than of absinthe. One or two drops of essence of absinthe produce terrible convulsions.

6th. Insanity, suicide, affections of the nervous system, follow a line exactly parallel to the consumption of alcohol.

7th. Alcohol, though an active poison, is an admirable medicine in certain cases. Those who are addicted to the use and abuse of alcohol cannot when they are unwell profit by the advantages of its medicinal power.

8th. Two litters of dogs have been raised, some with alcohol and some without. At the end of a month the alcoholized pups were miserable and dying, the others were in perfect condition.

9th. It is not yet known certainly whether alcohol burns in the organism or whether it is eliminated in breathing under the form of vapor of alcohol by the lungs, or of acetone or of acetate or of alcohol by the kidneys. This is a point demanding new investigations. In very small quantities it stimulates nutrition, but a medium amount arrests it. I do not believe that this stimulation of the nutrition is a good thing.

10th. With regard to instruction in schools for children and youth, certainly an understanding of the dangerous quality of alcohol is of advantage; but I imagine that the real remedy does not lie in that direction, and that society should defend itself by prohibition or at least by an increase of the tax in such a way that only the very rich could afford to be alcohol drinkers.

Professor C. VON VOIT, Munich, December 11, 1898. (Translation.)

You were so kind as to inform me of a movement which aims to calm the exaggerated agitation of the temperance question as well as to contradict certain unfounded physiological assertions. Many of the physiologists who were present at the International Physiological Congress in Cambridge have signed this document, and I should gladly also have done so had I agreed with certain of the less important points. I agree with you in the opinion that a moderate use of light alcoholic beverages, as for instance beer, is not injurious to health. I deem it therefore an exaggeration which may often lead to hypocrisy and to other bad results if the use of alcoholic beverages even in moderate quantities is prohibited. The same can be said of so many other articles whose use when exaggerated becomes injurious; it is only this *misuse* which should be prevented. I agree to and indorse the first part of the paragraph which says: "The physiological effects of alcohol when consumed in diluted form and in small quantities have, notwithstanding the continuous researches of the last few years, as yet not been satisfactorily demonstrated. Much remains still to be investigated in this matter." I do not, however, agree with the second part, as I consider that the views therein expressed have as yet not been clearly proved. It is here quite rightly said that alcohol is oxidized in the body, and that during this process it is changed into energy the same as other nutriments; but if in consequence of this we assert that it is physiologically wrong to call alcohol a poison, i. e., a substance that can never have useful but only dangerous effects, we then claim something that has as yet not been strictly proved. A substance may be consumed by the body and liberate energy and yet be harmful. I am not of the opinion that alcohol consumed in the aforesaid quantities is only a poison with dangerous effects, but I know not as yet whether or not it is *useful* to the healthy organism, — for it might be possible that alcohol is consumed and produces energy, i. e., heat, but that this heat leaves the body by causing the blood vessels of the skin to expand. As to the third paragraph, I agree to it with the exception of the last five words, for I do not believe that healthy persons can find that the use of alcohol benefits them. I should, however, not object to the third para-

graph if in it were said: "Judging from a purely physiological point no exact result can be mentioned which would oppose the views which many persons have drawn from their daily experience, namely, that alcohol consumed in the aforesaid manner injures their health." I drink beer, not on account of the alcohol it contains, which I could do without, but because I like its taste and because it quenches thirst in an agreeable manner.

APPENDIX II.

In the following pages will be found the Temperance Education Laws of the various States of the Union and the law of Congress applicable to the Territories, the District of Columbia, and the special schools under the charge of the United States government. For the States of Illinois and New York two laws are given, passed at different dates, showing how the Woman's Christian Temperance Union has been successful in substituting special and stringent legislation for the general provisions of the earlier laws. For the States of Connecticut and New Jersey two laws are also given (the more recent ones passed since this Report was prepared), showing that a reaction against such stringent legislation has begun. This law may be regarded as the result of a compromise between the teaching profession and the total abstinence associations. These laws are followed by a "comparative table of requirements of Scientific Temperance Laws" and by copies of the bills brought before the Committee on Education of the Massachusetts legislature in 1899, together with the letters used in the canvass of the schools as described in the Report.

UNITED STATES.

24 Statutes at Large, page 69.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled: —

Sec. 1. That the nature of alcoholic drinks and narcotics, and special instruction as to their effects upon the human system, in connection with the several divisions on the subject of physiology and hygiene, shall be included in the branches of study taught in the common or public schools, and in the military and naval schools, and shall be studied and taught as thoroughly and in the same manner as other like required branches are in said schools, by the use of text-book in the hands of pupils where other branches are thus studied in said schools, and by all pupils in all said schools throughout the Territories, in the military and naval academies in the United States, and in the

District of Columbia, and in all Indian and colored schools in the Territories of the United States.

Sec. 2. That it shall be the duty of the proper officers in control of any school described in the foregoing section to enforce the provisions of this act; and any such officer, school director, committee, superintendent, or teacher who shall refuse to comply with the requirements of this act, or shall neglect or fail to make proper provision for the instruction required and in the manner specified by the first section of this act for all pupils in each and every school under his jurisdiction, shall be removed from office, and the vacancy filled as in other cases.

Sec. 3. That no certificate shall be granted to any person to teach in the public schools of the District of Columbia or Territories, after the first day of January, Anno Domini eighteen hundred and eighty-eight, who has not passed a satisfactory examination in physiology and hygiene, with special reference to the nature and effects of alcoholic drinks and other narcotics upon the human system.

Approved May 20, 1886.

STATES.

ALABAMA.

Code of 1896.

Sec. 3546. 1. *Duties of the Superintendent of Education.* . . . 3. He shall make provision for instructing pupils in all schools and colleges supported, in whole or in part, by public money, or under state control, in hygiene and physiology with special reference to the effects of alcoholic drinks, stimulants, and narcotics upon the human system.

Sec. 3577. No certificate shall be granted hereafter to any new applicant to teach in the public schools of Alabama who has not passed a satisfactory examination in the study of the nature of alcoholic drinks and narcotics and of their effects upon the human system in connection with the several divisions of physiology and hygiene.

Sec. 3578. Every teacher shall give instruction as to the nature of alcoholic drinks and narcotics and their effects upon the human system, and such subjects shall be taught as regularly as any other in the public schools and in every grade thereof.

[These laws in substance enacted February 4, 1891, found at page 350 of the Alabama laws of that year, amended a statute passed February 26, 1887, at page 129 of the annual laws.]

ARKANSAS.

Acts of 1899, act 52.

Be it enacted by the General Assembly of the State of Arkansas:

Sec. 1. That Physiology and Hygiene, which must in each division

of the subject thereof include special reference to the effect of alcoholic drinks, stimulants, and narcotics upon the human system, shall be included in the branch of the study now and hereafter required to be regularly taught and studied by all the pupils in the common schools of this State.

Sec. 2. It shall be the duty of the Boards of Directors and County Examiners to see to the observance of this statute and make provision therefor, and it is especially enjoined upon the county examiner of each county that he include in his report to the State Superintendent of Public Instruction, the manner and extent to which the requirements of section 1 of this act are complied with in the schools and institutions of the county.

Sec. 3. After two years from the passage of this act no license shall be granted to any person to teach in the public schools of this State who has not passed a satisfactory examination in Physiology and Hygiene with special reference to the effect of alcoholic drinks, stimulants, and narcotics upon the human system.

Sec. 4. That this act take effect and be enforced from and after the first day of July, 1899.

Approved March 10, 1899.

CALIFORNIA.

Act approved March 15, 1889. Statutes and Amendments, 1889, 189.

Sec. 25. Section sixteen hundred and sixty-five of the Political Code is hereby amended so as to read as follows: —

1665. Instruction must be given in the following branches, in the several grades in which each may be required, viz.: . . . Elements of physiology and hygiene, with special instruction as to the nature of alcoholic drinks and narcotics and their effects upon the human system. . . .

[The words after "Elements of physiology" were first added by act approved March 15, 1887. Statutes and Amendments, 1887, 142.]

Act approved March 15, 1887. Statutes and Amendments, 1887, 142.

Sec. 2. Section one thousand six hundred and sixty-seven of the Political Code is hereby amended to read as follows: —

1667. Instruction must be given in all grades of public schools and in all classes during the entire school course, in manners and morals, and upon the nature of alcoholic drinks and narcotics and their effect upon the human system.

COLORADO.

2 Mills' Annotated Statutes, pages 2125, 2126.

Sec. 4043. The public schools of this State shall be taught in the English language, and the school board shall provide to have taught in such schools the branches specified in fifteen of said chapter, and such other branches of learning in other languages as they may deem expedient, including Hygiene with special reference to the effects of alcoholic stimulants and narcotics upon the human body. [G. L. 1877, page 835, sec. 2523; G. S. 1883, page 904, sec. 3073; as amended by L. 1887, page 401, sec. 37.]

[Sec. 15. Includes physiology and the laws of health.]

Sec. 4046. That the nature of alcoholic drinks and narcotics and special instructions as to their effects upon the human system, in connection with the several divisions of the subject of physiology and hygiene, shall be included in the branches of study taught in the public schools of the State, and shall be studied and taught as thoroughly and in the same manner as other like required branches are in said schools, by the use of text-books, designated by the board of directors of the respective school districts, in the hands of pupils where other branches are thus studied in said schools, and by all pupils in all said schools throughout the State.

Sec. 4047. That it shall be the duty of the proper officers, in control of any school, described in the foregoing section, to enforce the provisions of this act; and any such officer, school director, committee, superintendent, or teacher, who shall refuse, fail, or neglect to comply with the requirements of this act, or shall neglect, refuse, or fail to make proper provisions for the instruction required, and in the manner specified by the first section of this act, for all pupils in each and every school under his or her jurisdiction, shall be removed from office, and the vacancy filled as in other cases. [The last two sections were an act approved April 4, 1887. Laws of 1887, 378.]

CONNECTICUT.

Connecticut Laws, 1893, ch. 157, sec. 5, repealed sections 2100 and 2141 of the General Statutes of 1888. Sec. 2100 is ch. 139, and sec. 2141 is ch. 116 of the laws of 1886.

The 1893 law provides that: —

Sec. 1. The nature of alcoholic drinks and narcotics, and special instruction as to their effect on the human system, in connection with the several divisions of the subject of physiology and hygiene, shall be included in the branches of study taught in the common or public schools, and shall be studied and taught as other like required branches,

by the use of graded text-books in the hands of pupils where other branches are thus studied, and orally in the case of pupils unable to read, and by all pupils in all schools supported wholly or in part by public money.

Sec. 2. The text-books used for the instruction required by the preceding section for intermediate and primary pupils shall give at least one fifth of their space to the consideration of the nature and effects of alcoholic drinks and narcotics, and the books used in the highest grade of graded schools shall contain at least twenty pages of matter relating to this subject; but when this subject is massed wholly or in part in a chapter or chapters at the end of a book, such book shall not be considered as meeting the requirements of this law.

Act approved May 29, 1901. Public Acts, 1901, ch. 81.

Sec. 1. The effects of alcohol and narcotics on health, and especially on character, shall be taught in connection with hygiene, as a regular branch of study, to all pupils above the third grade in all graded public schools, except public high schools.

Sec. 2. Suitable text-books of physiology and hygiene, which explain the effects of alcohol and narcotics on the human system, shall be used in grades above the fifth in all graded public schools, except public high schools.

Sec. 3. The provisions of sections one and two of this act shall apply, in ungraded public schools, to classes corresponding to the grades designated in said sections.

Sec. 4. All normal schools and teachers' training schools shall give instruction in the subjects prescribed in section one of this act, and in the best methods of teaching such subjects.

Sec. 5. No certificate to teach in grades above the third shall be granted to any person who has not passed a satisfactory examination in the subjects prescribed in section one of this act.

Sec. 6. If it shall be satisfactorily proven to the comptroller that any town or district, having pupils above the third grade, has failed to meet the requirements of this act, such failure shall be deemed sufficient cause for withholding, in whole or in part, school dividends which such town or district would be entitled to receive.

Sec. 7. Chapter clvii. of the Public Acts of 1893, and sections 2100 and 2141 of the General Statutes, are hereby repealed.

DELAWARE.

Act approved May 12, 1898. Laws of 1898, ch. 67.

Sec. 16. It shall be the further duty of each of said committees and Boards of Education to see that all the pupils in all the free schools in the district are instructed in physiology and hygiene, with special refer-

ence to the effects of alcoholic drinks, stimulants, and narcotics on the human system, and to see that all the said schools are sufficiently supplied with such text-books relating to such subjects as are furnished the district in the distribution of free text-books hereinafter provided. Any teacher in any of the free schools of the State, failing to so instruct any pupils under his governance, shall, unless ordered to the contrary by a school officer having authority over him, be liable to a fine of twenty-five dollars, to be recovered before any justice of the peace of the proper county by any informer, and any school officer ordering a teacher under him not to instruct pupils as aforesaid shall be liable to light fine, recoverable as aforesaid by any informer.

[An earlier law was passed April 12, 1887, found in vol. 18, ch. 69 of the Laws of Delaware, and amended in 1893 at 347 of the laws of that year.]

FLORIDA.

Revised Statutes, sec. 242.

Each board of public institution is directed — . . . tenth.

To prescribe, in consultation with prominent teachers, a course of study for the schools of the county and grade them properly: and to require to be taught in every public school in the county over which they preside, elementary physiology, especially as it relates to the effects of alcoholic stimulants and narcotics, morally, mentally, and physically; and all persons applying for certificates to teach shall be examined upon this branch of the study, under the same conditions that other branches require by law.

[Law enacted June 8, 1889.]

GEORGIA.

This is the only State having no law on the subject.

IDAHO.

Act approved February 17, 1899. Session Laws, 1899, page 306.

Sec. 8. Teacher's Certificates — Qualifications — Signatures. He shall grant certificates to teachers in such form as the state superintendent of public instruction shall prescribe, and to those persons only who shall have attained the age of eighteen years, who have attended the said public examination, and shall be found to possess good moral character, thorough scholarship, and the ability to instruct and govern a school; but no certificate shall be granted to any person who shall not pass a satisfactory examination in orthography, reading, writing, grammar, arithmetic, geography, history of the U. S., civil government, physiology, and hygiene, with particular reference to the effects of alcoholic drinks, stimulants, and narcotics upon the human

system, theory and practice of teaching, state constitution, and so much of the general school laws as relates to the duties and responsibilities of teaching. All certificates shall be signed by the county superintendent, and no person shall be considered a qualified teacher within the meaning of the school law, who has not a certificate granted by the said superintendent or other legal authority. Provided: That all examination questions shall have been prepared as prescribed by law, furnished under seal, and opened before the applicants for certificates on the day of examination. Provided: That first grade certificates shall be granted to all applicants who are otherwise qualified according to law, and who shall have passed all the branches required in this section, and algebra in addition thereto, with a general average of not less than ninety per cent., and with a minimum of not less than seventy-five per cent. in any branch, and all applicants who are otherwise qualified according to law shall be granted second grade certificates who shall have attained a general average of eighty per cent., and a minimum in any branch of not less than seventy per cent., and third grade certificates shall be granted to all applicants who are otherwise qualified according to law, who shall have attained a general average of seventy-five per cent., and a minimum in any branch of not less than sixty per cent. Provided, further: That each applicant for teacher's certificate under the provisions of this act shall pay the county superintendent the sum of one dollar, the same to be deposited by him in the county treasury to the credit of the institute fund, to be used in institute work in addition to the regular appropriation.

ILLINOIS.

Act approved June 1, 1889. Laws of 1889, page 345.

1. Be it enacted by the people of the State of Illinois, represented in the General Assembly: that the proper legal school authorities shall have power, and it shall be their duty, to have all pupils of suitable age in schools of Illinois, supported by public money or under state control, instructed in physiology and hygiene, with special reference to the effects of alcoholic beverages, stimulants, and narcotics on the human system.

2. No certificate shall be granted to any person to teach in the public schools of Illinois after July, 1890, who has not passed a satisfactory examination in physiology and hygiene, with special reference to the effects of alcoholic beverages, stimulants, and narcotics on the human system.

Act approved June 9, 1897. Laws of 1897, 294 (Hurd's Revised Statutes, 1899, secs. 362, 363).

Sec. 1. Be it enacted by the people of the State of Illinois, represented in the General Assembly: that "an act relating to the study of physiology and hygiene in the public schools:" approved June 1, 1889, in force July 1, 1889, be amended so as to read as follows: —

That the nature of alcoholic drinks and other narcotics and their effects on the human system shall be taught in connection with the various divisions of physiology and hygiene as thoroughly as are other branches in all schools under state control, or supported wholly or in part by public money, and also in all schools connected with reformatory institutions.

All pupils in the above-mentioned schools below the second year of the high school and above the third year of school work, computing from the beginning from the lowest primary year, or in corresponding classes of ungraded schools, shall be taught and shall study this subject every year from suitable text-books in the hands of all pupils, for not less than four lessons a week for ten or more weeks of each year, and must pass the same tests in this as in other studies.

In all schools above mentioned all pupils in the lowest three primary years, or in corresponding classes in ungraded schools, shall each year be instructed in this subject orally for not less than three lessons a week for ten weeks in each year, by teachers using text-books adapted for such oral instruction as a guide and standard.

The local school authorities shall provide needed facilities and definite time and place for this branch in the regular course of study.

The text-books in the pupils' hands shall be graded to the capacities of the fourth year, intermediate, grammar, and high schools pupils, or to corresponding classes as found in ungraded schools.

For students below high school grade such text-books shall give at least one fifth their space, and for students of high school grade shall give not less than twenty pages to the nature and effects of alcoholic drinks and other narcotics. The pages on this subject, in a separate chapter at the end of the book, shall not be counted in determining the minimum.

Sec. 2. In all normal schools, teachers' training classes, and teachers' institutes, adequate time and attention shall be given to instruction in the best methods of teaching this branch, and no teacher shall be licensed who has not passed a satisfactory examination in this subject and the best method of teaching it.

Any school officer or officers who shall neglect or fail to comply with the provisions of this act shall forfeit and pay for each offense the sum of not less than five dollars nor more than twenty-five dollars.

INDIANA.

Act approved March 14, 1895. Laws of 1895, page 375 (Burns' Annotated Statutes, Revision of 1901, secs. 5984a, 5984b, and 5984c).

1. The nature of alcoholic drinks and narcotics and their effects on the human system in connection with the subject of physiology and hygiene, shall be included in branches to be regularly taught in the common schools of the State and in all educational institutions supported wholly or in part by money received from the State; and it shall be the duty of the Boards of Education and boards of such educational institutions, the township trustees, the Board of School Trustees, of the several cities and towns in this State to make provisions for such instruction in the schools and institutions under their jurisdiction, and to adopt such methods as shall adapt the same to the capacity of the pupils in the various grades therein; but it shall be deemed a sufficient compliance with the requirements of this section if provision be made for such instruction orally only, and without the use of text-books by the pupils.

2. No certificate shall be granted to any person on or after the first day of July, 1895, to teach in a common school or in any educational institution supported as aforesaid, who does not pass a satisfactory examination as to the nature of alcoholic drinks and narcotics and their effects upon the human system.

3. Any superintendent or principal of, or teacher in any common school or educational institution supported as aforesaid, who willfully refuses or neglects to give the instruction required by this act shall be dismissed from his or her employment.

IOWA.

Iowa Code, 1897.

Sec. 2677. Physiology and hygiene shall be included in the branches of study regularly taught to and studied by all pupils in the school, and special reference shall be made to the effect of alcoholic drinks, stimulants, and narcotics upon the human system, and the board of trustees shall provide the means for the enforcement of the provisions under this section and see that they are obeyed.

Sec. 2736. The examinations shall include competency in and ability to teach orthography, and physiology and hygiene, which latter, in each division of the subject, shall include special reference to the effects of alcohol, stimulants, and narcotics upon the human system. Candidates for examination in special studies need be examined in such branches only; but no special teacher shall be employed to teach any

study not included in the certificate. A record shall be kept of all examinations made, and the names, ages, and residences, with the date and result thereof.

Sec. 2737. The superintendent shall revoke the certificate of any teacher who shall fail or neglect to comply with the provisions of law relating to the teaching of physiology and hygiene, and such teachers shall be disqualified for teaching in any public school for one year thereafter. 26 G. A. ch. 39; 21 G. A. ch. 1, sec. 3.

Sec. 2739. The county superintendent shall annually, on the first Tuesday in October, make a report to the superintendent of public instruction, giving a full abstract of the several reports made to him by the secretaries and treasurers of school boards, stating the manner in and the extent to which the requirements of the law regarding instruction in physiology and hygiene are observed, and such other matters as he may be directed by the state superintendent to include therein, or he may think important in showing actual conditions of the schools in his county.

Sec. 2740. The county superintendent shall see that all provisions of the school law, so far as it relates to the schools or school officers within his county, are observed and enforced, specially those relating to . . . the introduction and teaching of such divisions of physiology and hygiene as relate to the effects of alcohol, stimulants, and narcotics upon the human system, and to this end he may require the assistance of the county attorney, who shall at his request bring any action necessary, to enforce the law or recover penalties incurred.

Sec. 2775. [The board of directors] shall require all teachers to give and all scholars to receive instruction in physiology and hygiene, which study in every division of the subject shall include the effects upon the human system of alcoholic stimulants, narcotics, and poisonous substances. The instruction in this branch shall of its kind be as direct and specific as that given in other essential branches, and each scholar shall be required to complete a part of such study in his class or grade before being advanced to the next higher, and before being credited with having completed the study of the subject.

[For prior legislation, see act approved February 17, 1886. Laws of 1886, ch. 1.]

KANSAS.

Act approved March 4, 1885. Laws of 1885, ch. 169 (General Statutes, 1897, ch. 63, § 206).

Sec. 1. No certificate shall be granted to any person to teach in any of the public schools of this State after the first day of January, 1886, who has not passed a satisfactory examination in the elements

of physiology and hygiene, with special reference to the effects of alcoholic stimulants and narcotics upon the human system; and provision shall be made by the proper officers, committees, and boards for instructing all pupils in each public school supported by public money and under state control upon the aforesaid topics.

KENTUCKY.

Sec. 4383, Kentucky Statutes, 1899. Act approved July 6, 1893. The instruction prescribed by the board shall embrace spelling . . . physiology and hygiene. . . . After July 1, 1893, the nature and effects of alcoholic drinks and narcotics upon the human system shall, in all schools supported wholly or in part by the State, be taught as thoroughly as other required studies to all pupils studying physiology and hygiene as a part of this branch.

LOUISIANA.

Act approved July 6, 1888. Acts of 1888, No. 40.

Sec. 1. Be it enacted by the general assembly of the State of Louisiana, that, in addition to the branches in which instruction is now given in the public schools, instruction shall also be given as to the nature of alcoholic drinks and narcotics, and special instruction as to their effects upon the human system, in connection with the several divisions of the subject of relative physiology and hygiene, and such subjects shall be taught as regularly as other branches are taught in said schools. Such instruction shall be given orally from a text-book in the hand of the teacher, to pupils who are not able to read, and shall be given by the use of text-books in the hands of the pupils in the case of those who are able to read, and such instruction shall be given as aforesaid to all pupils in all public schools in the State to all the grades until completed in the high schools.

Sec. 2. Be it further enacted, etc., That the text-book used for the instruction required to be given by the preceding section shall give at least one fourth of their space to the consideration of the nature and effects of alcoholic drinks and narcotics; and the books used in the highest grade of graded schools shall contain at least twenty pages of matter relating to this subject. Text-books on physiology in use in the schools at the time this act takes effect, which are not in accordance with the requirements of this section, shall be changed for books satisfying the requirements of this section, except when previous contracts as to such text-books are now in force.

Sec. 3. Be it further enacted, etc., That no certificate shall be granted hereafter to any new applicant to teach in the public schools of Louisiana who has not passed a satisfactory examination in the

study of the nature of alcoholic drinks and narcotics, and of their effects upon the human system, in connection with the several divisions of the subject of relative physiology and hygiene.

Sec. 4. Be it further enacted, etc., That each teacher of any school in this State supported wholly or in part by public money shall, before receiving any remuneration for services rendered in said capacity, file a certificate with the person by whom such payments are authorized to be made, to the effect that such teacher has faithfully complied with all the provisions of this act during the entire period for which such payment is sought and in the manner specified in this act, and no money shall be paid to any such teacher who has not filed such a certificate.

Sec. 5. Be it further enacted, etc., That this act shall take effect from and after its passage, provided that section 3, referring to examination of teachers, and section 4, to the payment of teachers, shall not take effect until on and after October 1, 1890.

MAINE.

Chapter 267 of the Public Laws of Maine of 1885, approved February 19, 1885.

Sec. 1. Provision shall be made by the proper local school authorities for instructing all pupils in all schools supported by public money or under state control in physiology and hygiene, with special reference to the effects of alcoholic drinks, stimulants, and narcotics upon the human system.

Sec. 2. No certificate shall be granted to any person to teach in the public schools of this State after the fourth day of July, 1885, who has not passed a satisfactory examination in physiology and hygiene, with special reference to the effects of alcoholic drinks, stimulants, and narcotics upon the human system.

MARYLAND.

Public General Laws, art. 77, ch. 7.

Sec. 40. The nature of alcoholic drinks and narcotics with special instruction as to their effects upon the human system, in connection with the several divisions of the subject of physiology and hygiene, shall be included in the branches of study taught in the public schools, and shall be taught to and studied by all pupils whose capacity will admit of it in all departments of the public schools of the State, and in all educational institutions supported wholly or in part by money from the State; and the said study shall be taught to and studied by said pupils in said schools as thoroughly and in the same manner as other like branches are there taught and studied, with text-books in the

hands of pupils, where other like branches are thus studied; and said text-books must be published, printed, and sold in the State of Maryland.

Sec. 41. It shall be the duty of the boards of county commissioners, and of the boards of commissioners of public schools of Baltimore City, county examiners, superintendents of public schools of Baltimore City, and boards of all educational institutions receiving aid from the State, to enforce the provisions of the preceding section.

[The above is ch. 495 of the laws of 1886.]

MASSACHUSETTS.

Revised Laws, ch. 42.

Sec. 1. . . . [The public] schools shall be taught by teachers of competent ability and good morals, and shall give instruction in . . . physiology and hygiene. . . . In each of the subjects of physiology and hygiene, special instruction as to the effects of alcoholic drinks and of stimulants and narcotics on the human system shall be taught as a regular branch of study to all pupils in all schools which are supported wholly or partly by public money, except schools which are maintained solely for instruction in particular branches.

[So enacted in substance in ch. 332 of the Acts of 1885.]

[See Acts of 1885, ch. 332, and Acts of 1898, ch. 496, sec. 1, which superseded it.]

MICHIGAN.

The people of the State of Michigan enact that section 15 of chapter 3 of act No. 164 of the Public Acts of 1881, entitled "An act to revise and consolidate the laws relating to public instruction and primary schools, and to repeal all statutes contravening the provisions of this act," approved May 21, 1881, as amended by act No. 93 of the Public Acts of 1883, approved May 16, 1883, be and the same is hereby amended so as to read as follows: —

Sec. 15. The district board shall specify the studies to be pursued in the schools of the districts, and in addition to the branches in which instruction is now required by law to be given in the public schools of the State, instruction shall be given in physiology and hygiene, with especial reference to the nature of alcohol and narcotics and their effect upon the human system. Such instruction shall be given by the aid of text-books in the case of pupils who are able to read, and as thoroughly as in other studies pursued in the same school. The text-books to be used for such instruction shall give at least one fourth of their space to the consideration of the nature and effects of alcoholic drinks, and narcotics, and the books used in the highest grade of graded

schools shall contain, at least, twenty pages of matter relating to this subject. Text-books used in giving the foregoing instruction shall first be approved by the State Board of Education. Each school board making a selection of text-books under the provisions of this act shall make a record thereof in their proceedings, and text-books once adopted under the provisions of this act shall not be changed within five years, except by the consent of a majority of qualified voters of the district present at an annual meeting. The district board shall require each teacher in the public schools of such district, before placing the school register in the hands of the director as provided in sec. 13 of this act, to certify therein whether or not instruction has been given in the school or grade presided over by such teacher, as required by this act, and it shall be the duty of the director of the district to file with the township clerk a certified copy of such certificate. Any school board neglecting or refusing to comply with any of the provisions of this act shall be subject to fine or forfeiture, the same as neglect of any other duty pertaining to their office. This act shall apply to all schools in the State, including schools in cities or villages, whether incorporated under special charter or under the general laws.

[This law was approved June 9, 1887, and is act 165 of the laws of that year. It may also be found in the Compiled Laws of Michigan, 1897. Act 108, laws of 1893, approved May 24, 1893, — sections 8426–8453 of the Compiled Laws of Michigan, — provides for the organization of corporations to instruct in the treatment of disease and in hygiene.]

MINNESOTA.

Act approved March 1, 1897. General Laws, 1887, ch. 123 (General Statutes, 1894, secs. 3892–3896).

Sec. 1. It shall be the duty of the boards of education, and trustees in charge of schools, and educational institutions supported in whole or in part by public funds, to make provision for systematic and regular instruction in physiology and hygiene, including special reference to the effects of stimulants and narcotics upon the human system.

Sec. 2. It shall be the duty of all teachers in public schools of the State to give systematic and regular instruction in physiology and hygiene, including special reference to the effects of stimulants and narcotics upon the human system; and any neglect or refusal on the part of such teachers to provide instruction as aforesaid shall be deemed sufficient cause for annulling his or her certificate by the county superintendent or other competent officer.

Sec. 3. No certificate shall be granted to any person to teach in the public schools of this State after January 1, 1888, who has not passed a satisfactory examination in physiology and hygiene, with special

reference to the effects of stimulants and narcotics upon the human system.

Sec. 4. It shall be the duty of the county superintendent of schools to report to the superintendent of public instruction any failure or neglect on the part of any board of education or trustees of a school or institution receiving aid in whole or in part from the State, to make provision for the instruction aforesaid, and such failure or neglect being satisfactorily proven by the county superintendent or by other persons, it shall be sufficient warrant upon which the superintendent of public instruction may withhold the apportionment of the current school fund from such district; provided, that not more than one fourth of said apportionment shall be withheld upon the first offense, one third upon the second, and one half upon any subsequent offense.

Sec. 5. The superintendent of public instruction and the presidents of the normal schools of this State are directed to recommend some suitable text-book, and to furnish the same at cost to the several school districts of this State, for the study of physiology and hygiene, with special reference to the effects of stimulants and narcotics upon the human system.

MISSISSIPPI.

Annotated Code, 1892, ch. 119.

Sec. 4019. The branches of study upon which teachers are required to be examined constitute the curriculum of the free public schools.

Sec. 4022. To obtain a first grade license, the applicant must be examined on spelling, reading, practical and mental arithmetic, geography, English grammar and composition, United States history, history of Mississippi, elements of natural philosophy, civil government, elements of physiology and hygiene, with special reference to the effects of alcohol and narcotics on the human system; and to obtain a second grade license, the applicant must be examined on spelling, reading, mental arithmetic, practical arithmetic, elementary geography, elementary English grammar and composition, and primary United States history, and primary physiology, with special reference to the effects of alcohol and narcotics on the human system; but a teacher qualified shall not be refused a certificate to teach for the next two years by reason of a want of sufficient knowledge on the subject of physiology.

Sec. 4023. To obtain a third grade license the applicant must be examined on the subjects required for second grade, and must make thereon an average of not less than sixty per centum, with not less than forty per centum on any subject.

MISSOURI.

Revised Statutes, 1899.

Sec. 9798. No person shall be granted a certificate to teach in any of the public schools established under the provisions of this chapter who is not of good moral character, and qualified to teach . . . physiology and hygiene, with special reference to the effects of alcoholic drinks and stimulants and narcotics generally upon the human system.

Sec. 9799. Physiology and hygiene, including their several branches, with special instruction as to the effect of alcoholic drinks, narcotics, and stimulants on the human system, shall constitute a part of the course of instruction, and be taught in all schools supported wholly or in part by public money, or under state control.

[See act approved April 2, 1885, Laws of 1885, 243; Revised Statutes, 1889, secs. 8023, 8024; and act approved March 19, 1897, Laws of 1897, 233.]

MONTANA.

Act approved March 11, 1895, found at sec. 1861 of the Montana Political Code.

All common schools shall be taught in the English language, and instruction shall be given in the following branches, viz.: . . . physiology and hygiene, with special reference to the effects of alcoholic stimulants and narcotics on the human system, history of the United States, civics of the United States and of Montana. Attention must be given during the entire school course to the cultivation of manners, to the laws of health, physical exercise, ventilation and temperature of the school-room.

NEBRASKA.

Ch. 83, Laws of 1885 (Compiled Statutes, 1899, secs. 4760, 4761).

Be it enacted by the Legislature of the State of Nebraska: —

Sec. 1. Provision shall be made by the proper local school authorities for instructing the pupils in all the schools supported by public money, or under state control, in physiology and hygiene, with special reference to the effects of alcoholic drinks and other stimulants and narcotics upon the human system.

Sec. 2. No certificate shall be granted to any person to teach in the public schools of the State of Nebraska, after the first day of January, 1886, who has not passed a satisfactory examination in physiology and hygiene, with special reference to the effects of alcoholic drinks and other stimulants and narcotics upon the human system.

Sec. 3. All acts and parts of acts inconsistent with this act are hereby repealed.

Approved March 5, 1885.

NEVADA.

Statutes, 1895, page 81, approved March 12 of that year.

Sec. 4. The powers and duties of the board shall be as follows: First, to describe and cause to be adopted a uniform series of text-books in the principal studies pursued in the public schools, to wit: . . . physiology and drawing. Special prominence shall be given in all public schools to the effect of alcoholic stimulants and of narcotics upon the human system.

NEW HAMPSHIRE.

Revised Statutes, ch. 92, sec. 6; as amended by ch. 40 (March 13) and ch. 50 (March 19) of the Session Laws of 1895. This law was passed in 1887. Ch. 52, sec. 1, of the laws of that year.

The School Board, Duties of: —

They shall prescribe in all mixed schools and all graded schools above primary, the studies of physiology and hygiene, having special reference to the effects of alcoholic stimulants and of narcotics upon the human system, and shall see that the studies so prescribed are thoroughly taught in said schools, and that well approved text-books upon the subjects are furnished to teachers and scholars. . . . Candidates shall be examined in the studies prescribed by law, or by the school board in accordance with law.

Ch. 94, sec. 2, of the Revised Statutes as amended by ch. 35 of the laws of 1895: —

The superintendent of public instruction . . . shall investigate the condition and the efficacy of the system of public education in the State, especially in relation to the amount and character of instruction given to the study of physiology and hygiene, having special reference to the effect of alcoholic stimulants and narcotics upon the human system, and shall recommend to the school boards what he considers the best text-books upon those subjects, and suggest to them the best mode of teaching them, and he shall pursue such a course for the purpose of awakening and guiding public sentiment in relation thereto as may to him seem best.

NEW JERSEY.

Public Laws of 1894, page 119, approved April 24, 1894 (General Statutes, page 3050, secs. 208–214).

A supplement to an act entitled "An act to establish a system of public instruction."

1. Be it enacted by the Senate and General Assembly of the State of New Jersey, That the nature of alcoholic drinks and narcotics, and

special instruction as to their effects upon the human system, in connection with the several divisions of the subject of physiology and hygiene, shall be included in the branches of study taught in the common or public schools, and shall be studied and taught as thoroughly and in the same manner as other like required branches, with adequate tests of the efficiency of the teaching, by the use of graded text-books in the hands of pupils where other branches are thus studied, and orally only in the case of pupils unable to read, and by all pupils in all grades of all schools supported wholly or in part by public money.

2. And be it enacted, That the space in the text-books devoted to the consideration of the nature of alcoholic drinks and narcotics and their effects upon the human system shall be sufficient for a full and adequate treatment of the subject.

3. And be it enacted, That no certificate shall be granted to any person to teach in the public schools of New Jersey, after January first next, one thousand eight hundred and ninety-five, who has not passed a satisfactory examination in physiology and hygiene, with special reference to the nature of alcoholic drinks and other narcotics and their effects upon the human system.

4. And be it enacted, That in order to carry into effect the provisions of this supplement each district shall, in the manner now provided by law, on or before the first day of July next, adopt a graded series of text-books in accordance with the provisions of this supplement.

5. And be it enacted, That the state superintendent of public instruction shall, immediately after the passage of this supplement, notify all boards of education, boards of school trustees, or other bodies having charge and control of public schools, of the provisions of this supplement, and particularly call their attention to their duty in enforcing the same.

6. And be it enacted, That it shall be the duty of all city and county superintendents to report to the state superintendent of public instruction whether the provisions of this act have been complied with, as specified in the preceding sections; and any refusal thus reported, or otherwise satisfactorily proven, shall be deemed sufficient cause for withholding the state appropriation of school money from such district or districts until such district or districts have fully complied with the provisions of this supplement.

7. And be it enacted, That this act shall apply to all schools in this State supported wholly or in part by money received from the State, whether such schools are governed by the act to which this is a supplement or by any special law, or the provisions contained in the charter of any city, town, borough, or other municipality, and that this act shall take effect at the beginning of the next school year.

Act approved March 23, 1900. Laws of 1900, ch. 96.

Sec. 259. The nature of alcoholic drinks and narcotics and their effects upon the human system shall be taught in all schools supported wholly or in part by public moneys as thoroughly and in the same manner as other like branches shall be taught, by the use of graded text-books in the hands of the pupils when other branches shall be thus taught and orally only in the case of pupils unable to read. In the text-books on physiology and hygiene the space devoted to the consideration of the nature of alcoholic drinks and narcotics and their effects upon the human system shall be sufficient for a full and adequate treatment of the subject. The failure or refusal of any district to comply with the provisions of this section shall be sufficient cause for withholding from such district the state appropriation.

Sec. 260. No certificate shall be granted to any person to teach in the public schools, except to persons applying for special certificates to teach music, drawing, manual training, or other subjects not included in the usual school curriculum, who shall not have passed a satisfactory examination in physiology and hygiene with special reference to the nature of alcoholic drinks and narcotics and their effects upon the human system.

NEW YORK.

Laws of 1884, ch. 30.

Sec. 1. Provision shall be made by the proper local authorities for instructing all pupils in all schools supported by public money, or under state control, in physiology and hygiene, with special reference to the effects of alcoholic drinks, stimulants, and narcotics upon the human system.

Sec. 2. No certificate shall be granted to any person to teach in the public schools of the State of New York after the first day of January, eighteen hundred and eighty-five, who has not passed a satisfactory examination in physiology and hygiene, with special reference to the effects of alcoholic drinks, stimulants, and narcotics upon the human system.

Act approved May 26, 1896. Laws of 1896, ch. 901.

The people of the State of New York, represented in Senate and Assembly, do enact as follows : —

Sec. 1. Sections nineteen and twenty of article six of title fifteen of chapter five hundred and fifty-six of the laws of eighteen hundred and ninety-four, known as the consolidated school law, as amended by chapter one thousand and forty-one of the laws of eighteen hundred and ninety-five, are hereby amended to read as follows: —

19. The nature of alcoholic drinks and other narcotics and their

effects on the human system shall be taught in connection with the various divisions of physiology and hygiene as thoroughly as are other branches in all schools under state control, or supported wholly or in part by public money of the State, and also in all schools connected with reformatory institutions.

All pupils in the above-mentioned schools below the second year of the high school and above the third year of school work, computing from the beginning of the lowest primary, not kindergarten, year, or in corresponding classes of ungraded schools, shall be taught and shall study this subject every year with suitable text-books in the hands of the pupils, for not less than three lessons a week for ten or more weeks, or the equivalent of the same in each year, and must pass satisfactory tests in this as in other studies before promotion to the next succeeding year's work; except that, where there are nine or more school years below the high school, the study may be omitted in all years above the eighth year and below the high school, by such pupils as have passed the required tests of the eighth year.

In all schools above mentioned, all pupils in the lowest three primary, not kindergarten, school years or in corresponding classes of ungraded schools, shall each year be instructed in this subject orally for not less than two lessons a week for ten weeks, or the equivalent of the same in each year by teachers using text-books adapted for such oral instruction as a guide and standard, and such pupils must pass such tests in this as may be required in other studies before promotion to the next succeeding year's work. Nothing in this act shall be construed as prohibiting or requiring the teaching of this subject in kindergarten schools.

The local school authorities shall provide needed facilities and definite time and place for this branch in the regular courses of study.

The text-books in the pupils' hands shall be graded to the capacities of fourth year, intermediate, grammar, and high school pupils, or to corresponding classes in ungraded schools.

For students below high school grade such text-books shall give at least one fifth their space, and for students of high school grade shall give not less than twenty pages to the nature and effects of alcoholic drinks and other narcotics. This subject must be treated in the text-books in connection with the various divisions of physiology and hygiene, and pages on this subject in a separate chapter at the end of the book shall not be counted in determining the minimum.

No text-book on physiology not conforming to this act shall be used in the public schools except so long as may be necessary to fulfill the conditions of any legal adoption existing at the time of the passage of this act.

All regents' examinations in physiology and hygiene shall include a due proportion of questions on the nature of alcoholic drinks and other narcotics, and their effects on the human system.

20. In all normal schools, teachers' training classes, and teachers' institutes, adequate time and attention shall be given to instruction in the best methods of teaching this branch, and no teacher shall be licensed who has not passed a satisfactory examination in the subject, and the best methods of teaching it.

On satisfactory evidence that any teacher has willfully refused to teach this subject, as provided in this act, the state superintendent of public instruction shall revoke the license of such teacher.

No public money of the State shall be apportioned by the state superintendent of public instruction or paid for the benefit of any city until the superintendent of schools therein shall have filed with the treasurer or chamberlain of such city an affidavit, and with the state superintendent of public schools a duplicate of such affidavit, that he has made thorough investigation as to the facts, and that to the best of his knowledge, information, and belief, all the provisions of this act have been complied with in all the schools under his supervision in such city during the last preceding legal school year; nor shall any public money of the State be apportioned by the state superintendent of public instruction, or by school commissioners, or paid for the benefit of any school district, until the president of the board of trustees, or in the case of common school districts the trustee or some one member of the board of trustees, shall have filed with the school commissioners having jurisdiction an affidavit that he has made thorough investigation as to the facts, and that to the best of his knowledge, information, and belief, all the provisions of this act have been complied with in such district, which affidavit shall be included in the trustees' annual report, and it shall be the duty of every school commissioner to file with the state superintendent of public instruction an affidavit in connection with his annual report, showing all districts in his jurisdiction that have not complied with all provisions of this act, according to the best of his knowledge, information, and belief, based on a thorough investigation by him as to facts; nor shall any public money of the State be apportioned or paid for the benefit of any teachers' training class, teachers' institute, or other school mentioned herein until the officer having jurisdiction or supervision thereof shall have filed with the state superintendent of public instruction an affidavit that he has made thorough investigation as to the facts, and that to the best of his knowledge, information, and belief, all the provisions of this act relative thereto have been complied with.

The principal of each normal school in the State shall at the close

of each of their school years file with the state superintendent of public instruction an affidavit that all the provisions of this law applicable thereto have been complied with during the school year just terminated, and until such affidavit shall be filed no warrant shall be issued by the state superintendent of public instruction for the payment by the treasurer of any part of the money appropriated for such school.

It shall be the duty of the state superintendent of public instruction to provide blank forms of affidavit required herein for use by the local school officers, and he shall include in his annual report a statement showing every school, city, or district which has failed to comply with all the provisions of this act during the preceding school year.

On complaint by appeal to the state superintendent of public instruction by any patron of the schools mentioned in the last preceding section, or by any citizen, that any provision of this act has not been complied with in any city or district, the state superintendent of public instruction shall make immediate investigation, and on satisfactory evidence of the truth of such complaint, shall thereupon and thereafter withhold all public money of the State, to which such city or district would otherwise be entitled, until all the provisions of this act shall be complied with in said city or district, and shall exercise his power of reclamation and deduction under section nine of article one of title two of the consolidated school law.

Sec. 2. This act shall take effect immediately.

NORTH CAROLINA.

Laws of 1891, ch. 169.

Be it enacted by the Senate and House of Representatives of the State of North Carolina in Legislature assembled: —

Sec. 1. That the nature of alcoholic drinks and narcotics, and special instruction as to their effects upon the human system, in connection with the several divisions of physiology and hygiene, shall be included in the branches of study taught in the common or public schools in the State of North Carolina, and shall be studied and taught as thoroughly and in the same manner as other like required branches are in said schools by the use of text-books in the hands of pupils where other branches are thus studied in said schools, and orally in the case of pupils unable to read, and shall be taught by all teachers and studied by all pupils in all said schools supported wholly or in part by public money.

Sec. 2. That the text-books used for the instruction required to be given in the preceding section in primary and intermediate grades shall give at least one fourth their space to the consideration of the nature and effects of alcoholic drinks and narcotics; and the books

used in the highest grade of graded schools shall contain at least twenty pages of matter relating to the subject.

Sec. 3. That no certificate shall be granted to any person to teach in the public schools of the State of North Carolina, after the first day of January, Anno Domini eighteen hundred and ninety-two, who has not passed a satisfactory examination in physiology and hygiene, with special reference to the nature of alcoholic drinks and other narcotics and their effects upon the human system.

Sec. 4. That it shall be the duty of the proper officers in control of any school described in the foregoing section to enforce the provisions of this act; and any such officer, school director, committee, superintendent, or teacher who shall refuse or neglect to comply with the requirements of this act, or shall neglect or fail to make proper provisions for the instructions required and in the manner specified by the first section of this act for all pupils in each and every school under his jurisdiction, shall be removed from office, and the vacancy filled as in other cases.

Sec. 5. This act shall be in force and effect from and after the first day of August, 1891.

Ratified February 27, 1891.

NORTH DAKOTA.

Revised Codes of North Dakota, 1895.

Sec. 750. Each teacher in the common schools shall teach pupils, when they are sufficiently advanced to pursue the same, the following branches: . . . physiology and hygiene, giving special instruction concerning the nature of alcoholic drinks, stimulants, and narcotics, and their effect upon the human system; physiology and hygiene and the nature of alcoholic drinks, stimulants, and narcotics, and their effect upon the human system, shall be taught as thoroughly as any branch is taught, by the use of a text-book to all pupils able to use a text-book, who have not thoroughly studied that branch, and orally to all other pupils. When such oral instruction is given as herein required a sufficient time, not less than fifteen minutes, shall be given to such oral instruction for at least four days in each school week. Each teacher in the special school districts, and in the cities organized for school purposes under special law, shall conform to and be governed by the provisions of this section.

Sec. 648. He [the county superintendent of schools] shall see that the pupils are instructed in the several branches of study required by law to be taught in the schools, as far as they are qualified to pursue them. If any teacher neglects or refuses to give instruction as required by law in physiology and hygiene, and the nature and effect of alcoholic

drinks, narcotics, and stimulants, the county superintendent shall promptly revoke such teacher's certificate and cause him to be discharged. If the teacher so neglecting or refusing to give instruction in said branches holds a state certificate, the county superintendent shall immediately certify such refusal or neglect to the superintendent of public instruction.

[Laws of 1890, ch. 62, secs. 29, 130; approved March 20, 1890.]

OHIO.

Act passed April 13, 1888. 85 Laws, page 213.

Sec. 1. Be it enacted by the General Assembly of the State of Ohio, That the nature of alcoholic drinks and narcotics, and their effects upon the human system in connection with the subjects of physiology and hygiene, shall be included in the branches to be regularly taught in the common schools of the State, and in all educational institutions supported wholly or in part by money received from the State; and it shall be the duty of the boards of education, and boards of such educational institutions, to make provisions for such instruction in the schools and institutions under their jurisdictions, and to adopt such methods as shall adapt the same to the capacity of the pupils in the various grades therein; but it shall be deemed a sufficient compliance with the requirements of this section if provision be made for such instruction orally only, and without the use of text-books by the pupils.

Sec. 2. No certificate shall be granted to any person on or after the first day of January, 1890, to teach in the common schools, or in any educational institution supported wholly or in part as aforesaid, who does not pass a satisfactory examination as to the nature of alcoholic drinks and narcotics, and their effect upon the human system.

Sec. 3. Any superintendent or principal of, or teacher in any common school or educational institution supported as aforesaid, who willfully refuses or neglects to give the instruction required by this act, shall be dismissed from his or her employment.

Sec. 4. This act shall take effect and be in force from and after the first day of January, 1889.

[Secs. 8092 33, 34, and 35 in Revised Statutes, 1890. See, also, sec. 4074 as to teachers' certificates; and sec. 4020 as to the authority of boards of education as to studies and text-books.]

OREGON.

Hill's Annotated Laws of Oregon, sec. 2649 (Statutes of 1885, 115, passed February 25, 1885).

A teacher's duty while in charge of the school shall be as follows:

. . . Third: To labor during school hours to advance the pupils in their studies; to create in their minds a desire for knowledge, principle, morality, politeness, cleanliness, and the preservation of physical health; and it is hereby made the duty of every teacher to give, and of every board of school directors to cause to be given, to all pupils suitable instruction in physiology and hygiene, with special reference to the effects of alcoholic drinks, narcotics, and stimulants upon the human system.

PENNSYLVANIA.

Act approved April 2, 1885. Laws of 1885, page 7.

Sec. 1. Be it enacted, etc., That physiology and hygiene, which shall, in each division of the subject so pursued, include special reference to the effect of alcoholic drinks, stimulants and narcotics upon the human system, shall be included in the branches of study now required by law to be taught in the common schools, and shall be introduced and studied as a regular branch by all pupils in all departments of the public schools of the Commonwealth, and in all educational institutions supported wholly or in part by money from the Commonwealth.

Sec. 2. It shall be the duty of county, city, borough superintendents, and boards of all educational institutions receiving aid from the Commonwealth, to report to the Superintendent of Public Instruction any failure or neglect on the part of boards of school directors, boards of school controllers, boards of education, and boards of educational institutions receiving aid from the Commonwealth to make proper provision in any and all the schools or districts under their jurisdictions for instruction in physiology and hygiene which, in each division of the subject so pursued, gives special reference to the effects of alcoholic drinks, stimulants and narcotics upon the human system as required by this act; and such failures on the part of directors, controllers, boards of education, and boards of educational institutions receiving money from the Commonwealth thus reported or otherwise satisfactorily proven, shall be deemed sufficient cause for withholding the warrant for state appropriation of school money to which such district or educational institution would otherwise be entitled.

Sec. 3. No certificate shall be granted any person to teach in the public schools of the Commonwealth or in any of the educational institutions receiving money from the Commonwealth, after the first Monday of June, Anno Domini one thousand eight hundred and eighty-six, who has not passed a satisfactory examination in physiology and hygiene, with special reference to the effects of alcoholic drinks, stimulants and other narcotics upon the human system.

RHODE ISLAND.

Ch. 60, sec. 7, of the General Laws (ch. 415, sec. 1, of the Laws of 1884, passed April 24, 1884).

The school committees of the several towns shall make provision for the instruction of the pupils in all schools supported wholly, or in part, by public money, in physiology and hygiene, with special reference to the effects of alcoholic liquors, stimulants, and narcotics upon the human system.

SOUTH CAROLINA.

Statutes at Large, vol. 22, sec. 27, at page 160; approved March 9, 1896.

An Act to declare the free school law of the State.

Sec. 27. It shall be the duty of the county board of education and of boards of trustees hereinafter provided for to see that in every school under their care there shall be taught, as far as practicable, . . . morals and good behavior, algebra, physiology and hygiene, and especially as to the effects of alcoholic liquors and narcotics upon the human system. . . .

SOUTH DAKOTA.

Act approved March 5, 1901. Session Laws, 1901, ch. 113.

Ch. viii. sec. 14 (page 177). Instruction shall be given in the common schools of the State in the following branches, in the several grades in which they may be required, viz.: . . . . physiology and hygiene, with special instruction as to the nature of alcoholic drinks and their effect upon the human system. . . .

[See chap. ii. sec. 4, of the same statute for the requirements for teachers' certificates. For earlier acts, see Session Laws, 1890, ch. 82, and Session Laws, 1897, ch. 57, ch. viii. sec. 13. See, also, Session Laws, 1901, ch. 113, ch. xi. sec. 30, for repeal of earlier acts.]

TENNESSEE.

Acts of 1895, ch. 180, secs. 1, 2, 3, taking effect January 1, 1896; approved May 14, 1895.

Sec. 1. Be it enacted, etc., That in addition to the branches in which instruction is now given in the public schools of this State, physiology and hygiene, with special reference to the nature of alcoholic drinks and narcotics, and smoking cigarettes, and their effects upon the human system, shall also be taught as thoroughly as other branches.

Sec. 2. That this shall be made a regular course of study for all pupils in all schools supported entirely or in part by public money.

Sec. 3. No certificate shall be granted to any person to teach in the public schools of this State after the first day of January, 1896, who

has not passed a satisfactory examination in physiology and hygiene, with special reference to the effects of alcoholic drinks and narcotics, and cigarette smoking upon the human system.

[Code of Tennessee, Annotated, 1896, secs. 1455, 1456.]

TEXAS.

Revised Statutes, as amended by the twenty-sixth Legislature (Laws of 1899, 234, 326).

Art. 3909a. All public schools in this State shall be required to have taught in them orthography, . . . physiology and hygiene, including the effects of alcoholic stimulants and narcotics on the human system. . . .

Art. 3973b. Teachers' certificates authorizing the holders thereof to contract and teach in the public free schools of this State shall be of three kinds, as follows: A county certificate, to be valid only in the county in which it is issued; a city certificate, to be valid only in the city in which it is issued; a state certificate, to be valid in all counties and independent districts of the State.

Art. 3974. An applicant for a third grade certificate shall be examined in spelling, . . . elementary physiology and hygiene, and the laws of health, with special reference to narcotics, and school management and methods of teaching. (1) An applicant for a second grade certificate shall be examined in the subjects prescribed for a third grade certificate, and in addition thereto, in United States history, . . . physiology and hygiene, and physical geography. (2) An applicant for a first grade certificate shall be examined in the subjects prescribed for third and second grade certificates, and in addition thereto, in physics, . . . and the effects of tobacco and alcoholic intoxicants upon the human system.

[See act approved May 20, 1893. General Laws of 1893, ch. 122, secs. 17, 65.]

UTAH.

Revised Statutes.

Sec. 1829. It shall be the duty of all boards of education and trustees in charge of schools and educational institutions supported in whole or in part by public funds to make provision for systematic and regular instruction in physiology and hygiene, including special reference to the effects of stimulants and narcotics upon the human system.

[This section is a part of ch. 49 of the Laws of Utah, 1897. This act was approved March 11, 1897. A similar clause was enacted by the legislature of Utah Territory, March 13, 1890.]

VIRGINIA.

[In Virginia, although a regulation of the board of education required instruction in physiology and hygiene, it was not until the winter of 1901–1902 that persistent effort has secured a law on the statute books.]

Act approved January 24, 1900. Acts of Assembly, 1899–1900, ch. 132.

In every public free school shall be taught . . . physiology and hygiene. . . . In the teaching of physiology and hygiene approved text-books shall be used, plainly setting forth the effects of alcohol and other narcotics on the human system; and these effects shall be as fully and thoroughly taught as other branches of said last-named subjects.

VERMONT.

Statutes, 1894.

Sec. 683. In every town there shall be kept for at least twenty-eight weeks in each year, at the expense of said town, by a teacher or teachers of competent ability and of good morals, a sufficient number of schools for the instruction of all the children who may legally attend all the public schools therein; and all pupils shall be thoroughly instructed in . . . elementary physiology and hygiene, with special reference to the effect of alcoholic drinks and narcotics on the human system. . . .

Sec. 822. [Applies to school districts.] All pupils shall be thoroughly instructed in . . . elementary physiology and hygiene. . . .

[For earlier legislation see Acts of 1886, No. 33, and Acts of 1888, No. 9, sec. 95.]

WASHINGTON.

Laws of 1897, ch. 118.

[The basis of this law may be found in the General Statutes, 1891, at secs. 810, 854, and 855, approved March 27, 1890.]

Sec. 58. It shall be the duty of all teachers to endeavor to impress on the minds of their pupils the principles of morality, truth, justice, temperance, and patriotism; to teach them to avoid idleness, profanity, and falsehood; to instruct them in the principles of free government, and to train them up to the true comprehension of the rights, duty, and dignity of American citizenship.

Sec. 65. All common schools shall be taught in the English language, and instruction shall be given in the following branches, viz.: Reading, . . . physiology and hygiene with special reference to the effects of alcoholic stimulants and narcotics on the human system, history of the United States, and such other studies as may be prescribed

by the state board of education. Attention must be given during the entire course to the cultivation of manners, to the laws of health, physical exercise, ventilation and temperature of the school-room, and not less than ten minutes each week must be devoted to the systematic teaching of kindness to not only our domestic animals, but to all living creatures.

Sec. 162. Upon complaint in writing being made to any county superintendent by any district clerk, or by any head of family, that the board of directors of the district of which said clerk shall hold his office, or said head of family shall reside, have failed to make provision for the teaching of hygiene, with special reference to the effects of alcoholic drinks, stimulants, and narcotics upon the human system, as provided in this act, in the common schools of such district, it shall be the duty of such county superintendent to investigate at once the matter of such complaints, and if found to be true, he shall immediately notify the county treasurer of the county in which such school district is located, and after the receipt of such notice, it shall be the duty of such county treasurer to refuse to pay any warrants drawn upon him by the board of directors of such district subsequent to the date of such notice, and until he shall be notified to do so by such county superintendent. Whenever it shall be made to appear to such county superintendent, and he shall be satisfied, that the board of directors of such district are complying with the provisions of said section of this act, and are causing physiology and hygiene to be taught in the public schools of such district as hereinbefore provided, he shall notify said county treasurer, and said treasurer shall thereupon honor the warrants of said board of directors.

Sec. 163. Any county superintendent of public schools who shall refuse or fail to comply with the provisions of the preceding section shall be liable to a penalty of one hundred dollars, to be recovered in a civil action in the name of the State in any court of competent jurisdiction, and the sum recovered shall go into the state school fund: and it shall be the duty of the prosecuting attorneys of the several counties of the State to see that the provisions of this section are enforced.

WEST VIRGINIA.

Acts of 1887, ch. 3.

The nature of alcoholic drinks and narcotics, and special instruction as to their effects upon the human system, in connection with the several divisions of the subject of physiology and hygiene, shall be included in the branches of study taught in the common or public schools, and shall be taught as thoroughly and in the same manner as other like

required branches are in the said schools, and to all pupils in all said schools throughout the State.

Approved February 17, 1887.

WISCONSIN.

Statutes, 1898, sec. 447a. Ch. 327 of the Laws of 1885.

Provision shall be made by the proper local school authorities for instructing all pupils in all schools supported by public money or under state control, in physiology and hygiene, with special reference to the effects of stimulants and narcotics upon the human system. The text-books used in giving such instruction shall have the joint approval of the state superintendent and the state board of health.

WYOMING.

Revised Statutes, 1889.

Sec. 612. Physiology and hygiene, which shall include in each division of the subject special reference to the effects of alcohol and narcotics upon the human system, shall be included in the branches taught in the common schools of the State, and shall be introduced and taught, either orally or by text-book, in all departments of the public schools above the second primary grade, and in all educational institutions supported wholly or in part by the State. (R. S. 1887, sec. 3969.)

Sec. 613. It shall be the duty of the several county and city superintendents of schools in the State, and of the secretary of the board of directors of all other educational institutions receiving aid from the State, to report to the state superintendent of public instruction any failure or neglect on the part of the board of trustees of any school district, or the board of directors of any educational institutions receiving aid from the State, to make proper provision for the teaching of the branches mentioned in the last preceding section in any or all of the schools or other educational institutions under their charge, or over which they have jurisdiction, and such failure on the part of the above mentioned officers, so reported and satisfactorily proven, shall be deemed sufficient cause for withholding the warrant for the district appropriation of school money to which such school district or educational institution would otherwise be entitled. (R. S. 1887, sec. 3970.)

Sec. 615. No certificate shall be hereafter granted to any person to teach in the schools of Wyoming who shall not pass a satisfactory examination in physiology and hygiene, with special reference to the effects of alcoholic drinks, stimulants, and narcotics upon the human system. (R. S. 1887, sec. 3972.)

[See Session Laws of Wyoming Territory, 1886, ch. 35.]

TERRITORIES.

ARIZONA.

Revised Statutes, 1901.

Sec. 2142. Every applicant for a first grade territorial certificate must be examined by written and oral questions in . . . physiology, hygiene, with special reference to the nature and effects of alcoholic drinks and other narcotics and stimulants upon the human system. . . . Applicants for a second grade certificate shall not be required to pass an examination in algebra or natural philosophy.

Sec. 2214. Instruction must be given in the following branches, viz.: . . . elements of physiology, hygiene, including the nature of alcoholic drinks and narcotics, and special instruction as to their effect upon the human system. . . .

NEW MEXICO.

New Mexico has no such law.

OKLAHOMA.

Statutes of Oklahoma.

Sec. 5817. Certificate of the first grade shall certify that a person to whom issued is proficient in, and fully qualified to teach, . . . physiology and hygiene. . . .

Sec. 5818. Certificates of the second grade may be issued to persons . . . able to teach all branches prescribed for first grade certificate. . . .

[All territories are governed by act of Congress given *supra*.]

Comparative Table of Requirements of Scientific Temperance Laws in the States of the Union.

Compiled from the Laws as in force January 1, 1896.

STATE.	Length of time study pursued.	Text-book required.	Percentage of matter in text-book.	Oral instruction to pupils who cannot read.	Exam required for teachers' certificates.	Penalty.
Alabama	As regularly as other branches.	Yes.	....	Yes.	Yes.	None.
Arkansas	General provision similar to our '84 law.	No.	....	....	Yes.	None.
California	Same as other branches.	No.	....	....	No.	None.
Colorado	As regularly as other branches.	When used in other branches.	....	....	No.	Removal from office.
Connecticut	As regularly as other branches.	Yes.	One fifth. 20 pp.	Yes.	Yes.	Loss of public money.
Delaware	As regularly as other branches.	Yes.	....	....	......	Not enforced (law not given).
Florida	No law.	....	....	....	......	....
Georgia	No law.	....	....	....	......	....
Idaho	No law. Similar to N. Y.	....	....	....	......	....
Illinois	General provision.	No.	....	....	Yes.	None.
Indiana	General provision.	No.	....	Oral instruction permissible in all grades.	Yes.	Dismissal.
Iowa	General provision.	No.	....	....	Yes.	Loss of public money.
Kansas	General provision.	No.	....	....	Yes.	None.
Kentucky	As thoroughly as other branches.	No.	....	....	No.	None.
Louisiana	As regularly as other branches.	Yes.	One fourth. 20 pp.	Yes.	No.	None.
Maine	General provision.	No.	....	....	Yes.	None.
Maryland	General provision.	Must be printed in the State.	....	....	No.	None.
Massachusetts	As a regular branch in all grades.	No.	....	....	No.	Same as for neglect of other branches.
Michigan	As thoroughly as other studies.	Yes.	One fourth. 20 pp.	....	No.	Fine or forfeiture.
Minnesota	General provision.	Supt. to recommend suitable ones.	....	....	Yes.	Loss of public money.
Mississippi	Same basis as arith. and geog.	No.	....	....	......	None.

Comparative Table of Requirements, etc. (continued).

STATE.	Length of time study pursued.	Text-book required.	Percentage of matter in text-book.	Oral instruction of pupils who cannot read.	Exam. required for teachers' certificates.	Penalty.
Missouri.....	When patrons so desire in writing.	No.	....	....	Yes.	None.
Montana.....	General provision.	No.	....	....	No.	None.
Nebraska	General provision.	No.	....	....	Yes.	None.
Nevada	General provision.	Prescribed by State Board.	....	....	No.	Loss of public money.
N. Hampshire	General provision in all schools above primary.	No.	....	....	No.	Fine.
New Jersey ..	All pupils. All grades.	Yes.	Full and adequate.	Yes.	Yes.	Loss of public money.
New York....	All pupils. Each year. 10 weeks, 4 lessons per week.	Yes.	One fifth. 20 pp.	Yes.	Yes.	Loss of public money.
N. Carolina ..	As thoroughly as other branches.	Yes.	One fourth. 20 pp.	Yes.	Yes.	Removal from office.
N. Dakota....	As thoroughly as other branches.	Yes.	....	Yes.	No.	None.
Ohio.........	General provision.	No.	....	Oral instruction sufficient in all grades.	Yes.	Dismissal.
Oregon.......	General provision.	No.	....	....	No.	None.
Pennsylvania.	As a regular branch.	No.	....	....	Yes.	Loss of public money.
Rhode Island.	General provision.	No.	....	....	No.	None.
So. Carolina..	As thoroughly as other branches.	When used in other branches.	One fourth. 20 pp.	Yes.	No.	Removal from office.
So. Dakota...	As thoroughly as arith. and geog.	Yes.	One fourth. 20 pp.	Yes.	Yes.	Loss of public money.
Tennessee....	As thoroughly as other branches.	No.	....	....	Yes.	None.
Texas........	General provision.	No.	....	....	No.	None.
Vermont.....	General provision.	No.	....	....	No.	None.
Virginia......	No general law. Local boards *may* introduce study.					
Washington..	General provision.	No.	....	....	No.	Loss of public money.
W. Virginia ..	As thoroughly as other branches and in like manner.	Except as before stated.	....	....	Yes.	Removal from office.
Wisconsin....	General provision.	Text-book to be approv'd by Supt. and B'd of Health.	....	....	No.	None.
Wyoming	All schools above 2d primary grade.	Optional, with oral instruction.	....	....	Yes.	Loss of public money.

CIRCULAR LETTER USED IN FIRST CANVASS OF PUBLIC SCHOOLS.[1]

To School Superintendents, Principals, Teachers, and School Committees of Massachusetts.

Your attention is called to the proposed legislation concerning instruction in physiology and hygiene in the public schools of Massachusetts. The texts are here given of —

(1) The present law.

(2) A bill introduced into the Senate, providing for the greatly increased stringency of the present law, with penalties for non-compliance with the same.

(3) A bill introduced into the House to provide for such instruction in physiology and hygiene as has been concluded by a conference of teachers and physicians to be adapted to promote the cause of temperance and the best welfare of the schools.

Appended is a statement of the grounds of the petition.

The Present Law. Statutes of 1885, *Chapter* 332.

Section 1. Physiology and hygiene, which, in both divisions of the subject, shall include special instruction as to the effect of alcoholic drinks, stimulants, and narcotics on the human system, shall be taught as a regular branch of study to all pupils in all schools supported wholly or in part by public money, except special schools maintained solely for instruction in particular branches, such as drawing, mechanics, art, and like studies. All acts or parts of acts relating to the qualification of teachers in the public schools shall apply to the branch of study prescribed in this act.

Sec. 2. All penalties now fixed for neglect to provide instruction in the branches of study now prescribed by law shall apply to the branch of study prescribed in section 1.

Sec. 3. This act shall take effect on the first day of August, in the year eighteen hundred and eighty-five.

Bill of Charles L. Morgan and Mary H. Hunt. Senate. No. 41.

[To accompany the petition of Charles L. Morgan and Mary H. Hunt for amendment of the law requiring physiology and hygiene to be taught in the public schools so as to more fully define the schools in which it shall be taught, the methods of instruction, and the character of text-books: to provide penalties for non-compliance with the requirements of the law: to provide for the supervision of the in-

[1] See Report, p. 40.

struction; and to provide for the enforcement of the law. Education.]

Commonwealth of Massachusetts. In the year One Thousand Eight Hundred and Ninety-nine.

To amend the Law requiring Physiology and Hygiene to be taught in the Public Schools.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows: —

Section 1. Section one of chapter three hundred and thirty-two of laws of A. D. eighteen hundred and eighty-five is hereby amended so as to read as follows: —

That the nature of alcoholic drinks and other narcotics and their effects on the human system shall be taught in connection with the several divisions of physiology and hygiene, as thoroughly as are other branches, in all schools supported wholly or in part by public money, including all evening common schools, and in all schools connected with reformatory institutions.

All pupils in the above-mentioned schools below the second year of the high schools and above the third year of school work, computing from the beginning of the lowest primary year, or in corresponding classes of ungraded schools, shall be taught and shall study this subject every year from suitable text-books in the hands of all pupils, in not less than three lessons a week for fourteen or more weeks of each year, and must pass the same tests for promotion in this as in other studies.

In all such schools all pupils in the lowest three primary school years, or in corresponding classes in ungraded schools, shall each year be instructed in this subject orally in not less than three lessons a week for ten weeks in each year by teachers using text-books adapted for such oral instruction as a guide and standard.

The text-books in the pupils' hands shall be graded to the capacities of the fourth year, intermediate, grammar, and high school pupils, or to corresponding classes in ungraded schools.

For students below high school grade such text-books shall give at least one fifth their space, and for students of high school grade, shall give not less than twenty pages to the nature and effects of alcoholic drinks and other narcotics. The pages on this subject, in a separate chapter at the end of the book, shall not be counted in determining the minimum. No text-book on physiology not conforming to this act shall be used in any public school except so long as may be necessary to fulfill the conditions of any legal adoption existing at the time of the passage of this act.

In all normal schools, teachers' training classes, and teachers' institutes adequate time and attention shall be given to instruction in this branch and the best methods of teaching it. All acts or parts of acts relating to the qualifications of teachers in the public schools shall apply to the branch of study prescribed in this act.

Nothing in this act shall be construed to apply to special schools maintained solely for instruction in particular branches, such as drawing, mechanics, art, and like studies.

Section 2. The school committee of all cities and towns, the principals of all normal schools, and the supervising officers in all schools connected with reformatory institutions shall annually provide a definite time and place in the regular course of study for the given number of lessons in this branch and an adequate supply of text-books for the pupils' use as required by this act, and also for the teachers' use for oral instruction in primary classes, and shall cause the requirements of this act to be complied with in all schools under their jurisdiction, and shall file with the Secretary of the State Board of Education an affidavit that all the provisions of this act have been complied with.

Any of the aforesaid officers who shall neglect or fail to comply with any of the provisions of this act shall forfeit and pay for each offense the sum of not less than five dollars and not more than twenty-five dollars. Failure to comply with all the provisions of this act on any school day to which it applies shall constitute an offense.

At the opening of each school year it shall be the duty of the Secretary of the State Board of Education to send to all school committees, principals of normal schools, and supervising officers of all schools connected with reformatory institutions, blanks containing the following questions: —

First. Have you provided a definite time and place in the course of study in the schools under your jurisdiction for three lessons per week for fourteen weeks per year in physiology and hygiene, which include the nature and effects of alcoholic drinks and other narcotics upon the human system as specified in section one of Act ——, and has that study been pursued by all pupils in all schools under your jurisdiction as specified by that act, with the same tests for promotion as in other studies?

Second. Have you provided text-books on the foregoing topics that are adapted to the several grades, and that give the specified space to the nature and effects of alcoholic drinks and other narcotics which the law demands?

The school officers to whom these blanks are sent shall return them at the close of the school year to the Secretary of the State Board of Education with answers filled out and an affidavit that they have made

thorough investigation as to the facts, and that to the best of their knowledge, information, and belief, these questions are truthfully answered, and that all the provisions of this act have been complied with in the schools under their jurisdiction during the preceding year.

Any failure thus reported or otherwise satisfactorily proven shall be deemed by the Secretary of the State Board of Education to be sufficient cause to compel the payment by such delinquents of the forfeiture specified in this act.

All penalties which apply to the failure of a city or town to make other returns or reports to the Secretary of the State Board of Education shall apply to failures to report as specified by this act.

The Secretary of the State Board of Education shall cause all the provisions of this act to be enforced, and shall report annually to the legislature any failure to comply with the same.

Trial justices, district, municipal, and police courts shall have jurisdiction of offenses under this act.

Section 3. This act shall take effect on the first day of August, in the year eighteen hundred and ninety-nine.

Bill of James J. Myers, House, No. 817.

House of Representatives, February 8, 1899. [Introduced on leave by Mr. Myers of Cambridge. Education.]

Commonwealth of Massachusetts, in the year One Thousand Eight Hundred and Ninety-nine.

An Act relative to Studies in the Public Schools.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows: —

Section 1. Section one of chapter three hundred and thirty-two of the acts of the year eighteen hundred and eighty-five is hereby amended by striking out in the fifth line thereof the words "all schools," and inserting in place thereof the words "the highest grade [1] of all grammar schools and in one grade at least of all high and Latin schools," so as to read as follows: —

Sec. 1. Physiology and hygiene, which, in both divisions of the subject, shall include special instruction as to the effects of alcoholic drinks, stimulants, and narcotics on the human system, shall be taught as a regular branch of study to all pupils in the highest grade [1] of all grammar schools and in one grade at least of all high and Latin schools supported wholly or in part by public money, except special schools maintained solely for instruction in particular branches, such as drawing, mechanics, art, and like studies. All acts or parts of acts

[1] To be amended to read "the fifth and highest grades," etc.

relating to the qualifications of teachers in the public schools shall apply to the branch of study prescribed in this act.

Sec. 2. The following new section is hereby inserted after section one of said chapter, as follows: —

Sec. 2. No text-book on physiology or hygiene shall hereafter be purchased for use in any public school unless it has been approved by the chairman and secretary of the state board of health and by the secretary of the state board of education.

Sec. 3. The last two sections of the said chapter are hereby renumbered.

Sec. 4. This act shall take effect upon its passage.

AN ANALYSIS OF THE BILLS NOW PENDING.

Senate Bill No. 41.

Mrs. Hunt's bill is an extremist's definition of the present law. Its purpose is "more fully to define (1) the schools in which physiology and hygiene shall be taught, (2) the methods of instruction, and (3) the character of text-books, (4) to provide the penalties for non-compliance with the requirements of the law, (5) to provide for the supervision of the instruction, and (6) to provide for the enforcement of the law."

The fundamental objections are: —

(1) Schools (and Grades). Pupils in the primary and lower grammar grades are too young to grasp the anatomical and physiological details necessary for the comprehension of the physiological and pathological action of stimulants and narcotics.

The moral effect upon pupils is lessened, if not destroyed, by the repetition of a comparatively limited number of statements which they have neither ability to understand nor opportunity to verify.

(2) Methods. The true method of temperance instruction should emphasize the social and moral aspects of the question and avoid so far as possible physiological and pathological details unsuited to the comprehension of the pupils.

(3) Text-Books. The text-books provided for by the proposed law devote too much space to the effects of stimulants and narcotics, while other equally important topics of hygiene, such as food, diet, sleep, clothing, cleanliness, and precautions against cold and wet are given too little attention.

(4), (5), and (6) Penalties and Supervision. The penalties for non-compliance are too severe, and the conditions of supervision of instruction are unprecedented.

An inquisitional system, subverting a wholesome relation between school officers and teachers, is inaugurated.

House Bill No. 817.

The bill introduced by Mr. Myers proposes (1) to have instruction in physiology and hygiene in the eighth grade[1] of grammar schools and one year in high schools, and

(2) To have a commission consisting of the chairman and secretary of the State Board of Health and the secretary of the State Board of Education to examine the books used for the purposes of this teaching in the schools, with the provision that no book shall be used which has not received the sanction of this commission.

(1) This provision for instruction insures that no pupil shall leave the schools without having the instruction; at the same time useless and deading repetition is avoided.

(2) The examination of the text-books insures good text-books, suitable because of accuracy of statement and adaptation to the intelligence of the pupil. It also protects the school officers and teachers against ill-considered local interference in the performance of their functions.

Petition.

We, the undersigned, because of our interest in the cause of temperance and of our belief that the failure of the present law is due to too much, rather than too little, teaching of the nature and effects of stimulants and narcotics, and too little emphasis on the moral and social aspects of the question, respectfully petition that House Bill No. 817 be enacted into law by the Senate and House of Representatives of the State of Massachusetts.

A. Lawrence Lowell, formerly of Boston School Committee.
Prof. W. T. Sedgwick, Mass. Institute of Technology.
Prof. H. P. Bowditch, Harvard Medical School.
Dr. H. P. Walcott, Chairman State Board of Health.
Prof. G. W. Fitz, Harvard University.
A Committee of the Massachusetts Medical Society to consider the instruction in Physiology and Hygiene in the public schools of the State.
Alice Freeman Palmer, State Board of Education.
Charles W. Eliot, President of Harvard University.
William Lawrence, Bishop of Massachusetts.
George Hodges, Dean of the Episcopal Theological School, Cambridge.
George A. Gordon, Pastor New Old South, Boston.
Frederick Edwards, Pastor Episcopal Church, Malden.
Prof. Nathaniel S. Shaler, Harvard University.

[1] To be amended to read "in the fifth and eighth grades."

Prof. Paul H. Hanus, History and Art of Teaching, Harvard University.

Prof. C. F. Hodge, Clark University.

Dr. Samuel W. Abbott, Secretary of the State Board of Health.

Supt. George E. Gay, President of the Massachusetts State Teachers' Association.

S. T. Dutton, Supt. of Schools, Brookline.

CIRCULAR LETTER USED IN SECOND CANVASS OF PUBLIC SCHOOLS.[1]

CAMBRIDGE, MASS., February 24, 1899.

To Superintendents and School Committees of Massachusetts: —

This blank is sent to you to get an expression of opinion regarding —

(1) Mrs. Hunt's modified bill, which is inclosed.

(2) Mr. Myers's bill, with the understanding that the instruction shall be given in the fifth and eighth grades of the grammar school and in one year of the high school, and that the text-books shall be approved as provided for.

(3) Mr. Myers's bill modified to require the teaching of physiology and hygiene with special reference to personal hygiene, including the nature and effects of stimulants and narcotics on the human system, to every pupil in the schools, but leaving the decision as to when this instruction shall be given, and the choice of text-books, to the local authorities, so that they may make their programmes suit local conditions.

G. W. FITZ, M. D.,
Sec. of the Mass. Medical Society Committee,
Harvard University, Cambridge, Mass.

MRS. HUNT'S MODIFIED BILL.

For the use of the Committee on Education.

[With reference to the petition of Charles L. Morgan and Mary H. Hunt for amendments of the law requiring physiology and hygiene to be taught in the public schools so as to more fully define the schools in which it shall be taught, the methods of instruction, and the character of text-books; to provide penalties for non-compliance with the requirements of the law; to provide for the supervision of the instruction; and to provide for the enforcement of the law.]

Commonwealth of Massachusetts. In the year One Thousand Eight Hundred and Ninety-nine.

An Act relative to Teaching Physiology and Hygiene in the Public Schools.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows: —

[1] See Report, p. 40.

Section 1. Section one of chapter three hundred and thirty-two of laws of Anno Domini eighteen hundred and eighty-five is hereby amended so as to read as follows: —

The nature of alcoholic drinks and narcotics and their effects on the human system, shall be taught in connection with the several divisions of physiology and hygiene, as thoroughly as are other branches, in all schools supported wholly or in part by public money, including all schools connected with reformatory institutions.

All pupils in the above-mentioned schools below the second year of the high schools and above the third year of school work, computing from the beginning of the lowest primary year, or in corresponding classes of ungraded schools, shall be taught and shall study physiology and hygiene, including the nature and effects of alcoholic drinks and narcotics, every year, with text-books in the hands of all pupils, not less than three lessons a week for ten or more weeks of each year, or the equivalent of the same each year. All pupils must pass the same tests for promotion in this, as in other studies. In cases where there are nine years below the high school, the study may be omitted in the ninth year, or in the first year of the high school, but not in both.

In all public schools all pupils in the lowest three primary school years, or in corresponding classes in ungraded schools, shall each year be instructed in this subject orally in not less than three lessons a week for ten weeks in each year, or the equivalent of the same each year, by teachers using text-books adapted for such oral instructions as a guide and standard.

The text-books in the pupils' hands shall be graded to the capacities of the fourth year, intermediate, grammar, and high school pupils, or to corresponding classes in ungraded schools.

For students below high school grade such text-books shall give at least one fifth their space, and for students of high school grade, shall give not less than twenty pages to the nature and effects of alcoholic drinks and narcotics. The treatment of the effects of alcoholic drinks and narcotics shall be incorporated with each division of the subject of physiology and hygiene in all text-books used in compliance with this act.

In all state teachers' institutes and in all state normal schools, the State Board of Education shall cause adequate instruction to be given in the best methods of teaching this branch as required by this act.

Nothing in this act shall be construed to apply to special schools maintained solely for instruction in particular branches, such as drawing, mechanics, art, and like studies.

Sec. 2. The school committees of all cities and towns, the county commissioner in control of all truant schools, and the supervising

boards, trustees, or other officers in control of all schools connected with reformatory institutions, shall annually, at the beginning of the school year, provide a definite time and place in the regular course of study for the given number of lessons in this branch, and an adequate supply of text-books for the pupils' use, as required by this act, and also for the teachers' use for oral instruction in primary classes; and shall cause the requirements of this act to be complied with in all schools under their jurisdiction. The school committees of all cities and towns shall state in their reports to the Secretary of the State Board of Education, whether all the provisions of this act, according to the best of their knowledge and belief, have been thus complied with.

Any member of a school committee or board, or any trustee, or supervising officer connected with a reformatory institution, who shall neglect or refuse to coöperate in securing compliance with any of the provisions of this act, after thirty days' notice and a continuance of such neglect or refusal, shall pay a fine for such neglect or refusal of the sum of not less than twenty-five dollars.

It shall be the duty of the Secretary of the State Board of Education to send annually to all school committees, blanks containing the following questions: —

First. Have you provided, during the last school year in the schools under your jurisdiction, a definite time and place in the course of study for the required number of lessons for all pupils in physiology and hygiene, including the nature and effects of alcoholic drinks and narcotics upon the human system as specified in section one of Act [ ] and have you required that study to be pursued by all pupils in all schools under your jurisdiction as specified by that act, with the same tests for promotion as in other studies?

Second. Have you provided text-books on the foregoing topics that are adapted to the several grades, and that give the specified space to the nature and effects of alcoholic drinks and narcotics which the law demands?

Every school committee to whom these blanks are sent shall return them at the close of the school year to the Secretary of the State Board of Education, with answers filled out and an affidavit that these questions are truthfully answered.

The Secretary of the State Board of Education shall include in his annual report to the legislature a report concerning the compliance with the requirements of this act.

Trial justices, district, municipal, and police courts shall have jurisdiction of offenses under this act.

Sec. 3. This act shall take effect on the first day of August, in the year eighteen hundred and ninety-nine.

THE INFLUENCE OF ALCOHOL AND ALCOHOLIC BEVERAGES

ON

DIGESTION AND SECRETION.

By Dr. R. H. CHITTENDEN.

DIGESTION AND SECRETION.

I.

DEFINITIONS OF TECHNICAL TERMS AND EXPLANATIONS FOR LAY READERS.

PHYSIOLOGICALLY speaking, digestion is a somewhat broad term including a variety of processes, all having for their object, however, the conversion of the several classes of foodstuffs into forms capable of being absorbed and utilized by the body. These processes are chemico-physiological in nature, involving not only the simple solvent or digestive action of the several digestive juices, i. e., the purely chemical processes, but also the purely physiological processes of secretion, absorption, peristalsis, etc. The fluids most intimately concerned in digestion are the saliva, gastric juice, and pancreatic juice, while the bile and the *succus entericus*, i. e., the secretion from the small intestine, are likewise valuable aids.

The saliva is manufactured and secreted by three sets of glands known as the parotid, submaxillary, and sublingual glands, which pour their secretions into the mouth cavity, where they mingle with the secretion from the buccal glands, the mixture constituting the so-called *mixed saliva*. The gastric juice is secreted by the tiny cells contained in the mucous membrane of the stomach, while the pancreatic juice is manufactured in the pancreatic gland and brought to the small intestine, when required, through a small duct or tube. These secretions have their origin primarily in the blood; that is, the blood brings to the glands nutritive material which the gland cells work over and eventually transform into the specific substances characteristic of the respective secretions.

These various digestive fluids are secreted only under the influence of stimulation, mainly reflex through the nerves going to and coming from the glands, although mechanical stimulation may likewise be effective in some degree, particularly with

the saliva and gastric juice. Many circumstances combine to modify the extent and quality of the secretion furnished by these several glands, i. e., the character and extent of the stimulation, so that constant fluctuation, within certain limits, may be expected in the volume and concentration of the fluids from day to day, and hence in their physiological activity likewise. Thus, influences which affect the volume and character of the blood flowing through the glands, local blood-pressure, etc., as well as the character and amount of the ingested food, all have an effect upon the volume and composition of the secretions.

The digestive power of these several secretions is dependent mainly upon the presence of specific ferments or enzymes, manufactured in the glands, which, acting upon the foodstuffs under suitable conditions, render them soluble and diffusible and so capable of being absorbed. The saliva is a slightly alkaline fluid, and in virtue of the enzyme (ptyalin) it contains acts upon starchy or farinaceous foods, transforming them into soluble dextrins and sugars, — a process which commences in the mouth and continues for a brief time in the stomach, until the enzyme is finally destroyed by the increasing acidity of the gastric juice. This starch-digesting action of the saliva is frequently spoken of as *amylolytic* action, while the active agent may be described as an *amylolytic* ferment or enzyme. The gastric juice is an acid-reacting fluid containing normally about two tenths per cent. of hydrochloric acid, the enzyme pepsin and a milk-curdling enzyme known as rennin. The main action of the gastric juice, in virtue of the contained pepsin-hydrochloric acid, is upon the proteid or albuminous foods transforming them into a number of products, chiefly proteoses and peptones, characterized especially by their solubility and diffusibility. This proteid-digesting power is described as *proteolytic* action, and the enzyme which accomplishes the transformation of the proteid is known as a *proteolytic* enzyme. When the acid chyme, i. e., the semi-digested mass in the stomach, leaves the latter organ, it passes through the pyloric orifice into the small intestine, where it is exposed to the double action of the bile and pancreatic juice. The latter is a powerful digestive fluid of strong alkaline reaction, containing three distinct enzymes. One of these is an amylolytic or starch-digesting enzyme essentially identical with the enzyme of saliva and converts any unchanged

starch into soluble dextrins and sugar. The second ferment is a powerful proteolytic enzyme known as trypsin which in a neutral or alkaline-reacting fluid transforms proteid matter into a row of soluble products different in nature from those formed in acid gastric digestion. The third ferment is an adipolytic or fat-splitting enzyme which transforms at least a portion of the fats of the food into soluble forms. This threefold action of the pancreatic juice may continue for some time in the small intestine, but as the peristaltic or wave-like contraction of the intestinal walls tends to push the contents of the tube onward toward the large intestine, and as absorption is quite rapid at this point, the conditions gradually become unfavorable for further digestive action.

From the foregoing, it is plain that digestion, broadly speaking, may be modified in a variety of ways, notably through the influence of agencies affecting the nervous system, thereby modifying the rate and character of the secretions coming from the digestive glands. Thus, agents introduced with the food, as well as the food itself, may after their absorption into the circulation lead to changes in the rate of flow and composition of the blood passing through the glands, modifying thereby the amount of material available for the manufacture of the several digestive secretions. Further, these agents may exert a specific influence upon the nerves which directly govern secretion, thereby directly affecting the manufacture and flow of the individual digestive fluids. Again, the mere presence of substances introduced with the food may exert an influence upon the digestive or solvent action of the secretions, thus modifying the rate of digestion. For example, the presence of salt in the stomach-contents may lead to an acceleration of gastric digestion through a simple acceleration of ferment action, while larger quantities of the same salt in the stomach may retard gastric digestion through inhibition of ferment action. Obviously, the duration of this acceleration or retardation of gastric digestion would depend primarily upon the length of time the salt remained in the stomach, i. e., upon the rapidity of its absorption and consequent removal from the alimentary tract. Still again, the rate of digestion may be modified by agents which, absorbed into the blood, act upon the nerves, controlling the motor functions of the stomach and intestine. Thus, normally the latter

organs are constantly in motion, producing a more or less constant agitation or churning of the respective contents which serves to intimately mingle the food particles with the digestive juices, thereby accelerating digestion. Hence, everything else being equal, anything which tends to accelerate peristalsis will in turn accelerate the rate of digestion, while, on the other hand, retardation of peristalsis may be accompanied by inhibition of digestion. Lastly, the rate of absorption from the alimentary tract exercises an influence upon the speed of digestion; consequently any agent which, for example, modifies the flow of blood along the gastro-intestinal tract, thus influencing the rate of absorption, may indirectly affect the speed of digestion. It is thus plainly evident that what we term digestion may be influenced through a variety of channels, but the two more important ways in which digestion may be modified are through changes in the rate of flow and composition of the digestive fluids, i. e., changes in secretion, and through changes (either acceleration or retardation) in the rate of digestive action caused by the mere presence of some substance in the digestive mixture, i. e., through a direct influence upon the purely chemical processes of digestion. Moreover, it is obvious likewise that a substance may exercise an inhibitory influence in one direction, as upon the chemical process of digestion, while leading to an acceleration in another direction, as on secretion. Further, a given agent may produce one effect on salivary digestion and quite a different effect on gastric digestion. Obviously, therefore, in studying the influence of alcoholic beverages on digestion, there are many lines of inquiry which must receive attention.

II.

GENERAL CONCLUSIONS AS TO THE INFLUENCE OF ALCOHOL AND ALCOHOLIC BEVERAGES ON DIGESTION.

As already indicated, digestion may be influenced by alcoholic fluids in several ways, notably by influencing the rate of secretion of the digestive fluid, either increasing or diminishing the rate of flow and thereby increasing or decreasing the volume of digestive fluid available, and also by modifying either favorably or unfavorably the chemical composition of the secretion. Further, the presence of the alcoholic fluid, in the stomach for example, may exercise a direct influence upon the chemical processes of digestion, either augmenting or retarding the natural solvent or digestive action of the secretion. Again, digestion may be influenced indirectly by the action of an alcoholic fluid upon the rate of absorption and upon the peristaltic movements of the intestine, since both of these factors exert an influence upon the rapidity of digestion.

1. Gastric Digestion.

a. Influence of alcohol and alcoholic beverages on the secretion of gastric juice. The results of the experiments carried out by the writer and his assistants on the influence of alcohol and alcoholic beverages on the secretion of gastric juice lead to some very definite conclusions. The data obtained and presented in detail in the subjoined report tend to show that when alcohol and alcoholic fluids are taken into the stomach there is a marked increase in the flow of gastric juice accompanied by an increase in the content of the essential constituents, pepsin and hydrochloric acid, as well as in the content of total solid matter. Moreover, this stimulating effect of alcohol and alcoholic beverages upon the secretion of gastric juice is not limited to a direct action dependent upon the presence of the alcoholic fluid in the stomach, but is exerted likewise indirectly through the influence of alcohol absorbed from the intestine. Thus, if the

intestine is entirely shut off from the stomach by a ligature at the pylorus, the introduction of an alcoholic fluid into the intestine is followed by a stimulation of the gastric glands accompanied by an outpouring of the gastric secretion. Whiskey, brandy, sherry, claret, beer, and porter, as well as pure alcohol, all agree in producing direct and indirect stimulation of gastric secretion, increasing both the rate of flow of the gastric juice and the concentration of the fluid.

Of special importance in this connection is the fact, brought out by experiment, that when alcohol and alcoholic beverages are introduced into the alimentary tract there is a very rapid absorption of the alcohol into the circulation. The alcohol quickly leaves the stomach and intestine passing into the blood, this act being accompanied by an inrush of acid gastric juice in large quantity. Even from the stomach, where absorption is ordinarily comparatively slight, the absorption of alcohol goes on with considerable rapidity. Thus, the introduction of two hundred c. c. of thirty-seven per cent. alcohol into the stomach of a dog with the intestine ligated at the pylorus may be followed by the nearly complete disappearance of the alcohol in three hours by absorption through the stomach walls into the blood. When the outlet from the stomach into the intestine is open, then the rate of absorption of alcohol is greatly increased. Alcohol unquestionably disappears from the alimentary tract quite rapidly. Thus, in one experiment, fifty c. c. of twenty per cent. alcohol were introduced into the stomach of a dog with a gastric fistula, and on withdrawal of the stomach-contents half an hour later no alcohol whatever was found in the forty c. c. of fluid obtained. In view of this rapid disappearance of alcohol from the alimentary tract it is plain that alcoholic fluids cannot have much, if any, direct influence upon the secretion of either pancreatic or intestinal juice. Further, it is equally clear that the rapid removal of alcohol from the stomach by absorption must tend to diminish considerably any influence the presence of alcohol might exert upon the solvent or digestive action of the gastric juice in the stomach.

The conclusion is therefore obvious that when alcoholic fluids are taken into the stomach there is first a direct stimulation, leading to the rapid secretion of a powerful gastric juice. This is followed by a more or less rapid absorption of the alcohol

accompanied in turn by an indirect or secondary stimulation of gastric secretion. These conclusions are in accord with many previous observations bearing upon this subject. Thus, in many of the older handbooks of physiology the statement is frequently found that "alcohol is a strong stimulant of gastric secretion," and it has been a common practice to use alcohol as a means of obtaining gastric juice from dogs with gastric fistulæ.[1] Gluzinski, in 1886, reported that when brandy and dilute alcohol were administered to men these fluids gave rise, after a brief preliminary period, to the formation of a very active gastric juice, rich in hydrochloric acid. Wolff, in 1889, found that cognac in small doses increased the secretion of hydrochloric acid. He reports in addition, however, that in larger quantity it decreases the acidity of the gastric juice. Klemperer, in 1890, observed that moderate doses of alcohol led to a very slight increase in the secretion of gastric juice, while in the same year Blumenau reported that the introduction of twenty-five to fifty per cent. alcohol into the healthy human stomach acts as a secretory stimulant, bringing about an increased flow of gastric juice with rise of acidity. Brandl, in 1892, experimenting with fistulous dogs, found that alcohol — as contrasted with water — introduced with foodstuffs into the stomach brings about an unfailing, though not particularly large, increase in gastric secretion. Lastly, Haan, in 1895, with repeated and increasing doses of alcohol observed an augmentation in the acidity of the gastric secretion from the dog, followed after a few days by a diminution in the amount of secretion and a gradual decline in acidity. It is thus apparent that, in a general way at least, there is a perfect agreement between our observations upon this subject and the recorded observations of other physiologists. Further, there is no necessary inconsistency between the stimulating action of alcohol upon gastric secretion and the quite probable detrimental action of larger doses frequently repeated. As stated by both Heidenhain and Lauder Brunton, large amounts of alcohol are regarded as detrimental to the stomach, giving rise eventually to a pathological condition, a statement which is doubtless correct. It has been our aim, however, to ascertain the physiological action of alcoholic beverages upon gastric

[1] The authority for these and some of the following statements will be found in the references on pages 251–253 of this report.

secretion, and upon this point our conclusions are quite definite that they act as stimulants.

b. Influence of alcohol and alcoholic beverages on the chemical processes of gastric digestion. Our experiments upon this subject have been very numerous, and for the detailed results reference must be made to the subjoined report. It will suffice here to state merely our general conclusions, bearing in mind, however, that these have to do simply with the action of various alcoholic fluids upon the chemical processes of gastric digestion, i. e., the influence of the presence of alcoholic fluids in the stomach upon the solvent or digestive action of the gastric juice on proteid foods.

Pure ethyl alcohol, when mixed with the stomach-contents or with an artificial pepsin-acid solution, has little or no effect on pepsin-proteolysis when present in small amount, say one or two per cent. of absolute alcohol. Not until the digestive mixture contains five to ten per cent. of absolute alcohol is the action of the gastric juice materially interfered with. With these proportions of absolute alcohol, equal to ten or twenty per cent. of proof spirit, retardation of proteolysis becomes noticeable, while in the presence of fifteen to eighteen per cent. of absolute alcohol digestive action may be reduced one quarter or even one third. Especially noteworthy is the fact that the extent of retardation by a given percentage of alcohol varies greatly with the strength or activity of the gastric juice and with the digestibility of the proteid food. Everything else being equal, the greater the strength or digestive power of the gastric juice, the less is the retardation; while, on the other hand, the weaker the gastric juice, the greater is the inhibitory action of a given amount of alcohol. Normally, however, it is safe to say that until the stomach-contents contain ten per cent. of proof spirit, there is no appreciable retardation of the solvent action of the gastric juice.

Strong alcoholic beverages, such as whiskey, brandy, rum, and gin, ordinarily containing from forty to fifty per cent. of absolute alcohol, have an action upon gastric digestion practically proportional to the amount of alcohol present. Thus, with a vigorous gastric juice, the presence of ten per cent. of whiskey results simply in a slight retardation of digestive action. With a weak gastric juice, the retardation is much greater. When

digestive action is fairly vigorous, the presence of small percentages of whiskey causes practically no retardation. The detailed results of our experiments in this direction, given in the subjoined report, lead to the conclusion that pure whiskey, rum, brandy, and gin are no more deleterious to the digestive action of gastric juice than corresponding strengths of absolute alcohol, and that in the healthy individual these liquors can be considered to directly impede the gastric digestion of proteid foods only when taken immoderately and in intoxicating doses. The possible presence of so-called fusel oils in whiskey, as an impurity, cannot materially modify the action of this alcoholic beverage on gastric proteolysis. Our experiments tend to show that in small quantities the higher alcohols characteristic of fusel oils are prone to increase somewhat the solvent action of the gastric juice, and it is only when present in large amounts, far larger than would be possible when introduced as an impurity in whiskey, that they show any decided inhibitory action.

In considering the influence of wines upon the solvent action of the gastric juice, they may be divided for convenience into the two classes of heavy and light wines, i. e., those which contain a comparatively large percentage of alcohol, as sherry, and those which contain a smaller amount of alcohol, as claret, and hocks. With such samples of sherry wine as we have experimented with — samples containing from twenty to twenty-one per cent. of alcohol — there is marked retardation of gastric proteolysis. The inhibition produced is out of all proportion to the amount of alcohol present. Indeed, the presence in a digestive mixture of five per cent. of sherry, equal to not more than one per cent. of absolute alcohol, has a far greater retarding effect on the solvent action of the gastric juice than even five per cent. of absolute alcohol. That the inhibitory action of the sherry is not due to the alcohol or other volatile matters contained in the fluid is apparent from the fact that when the distillate from the wine is added to an artificial gastric juice, in amount equal to ten per cent. of the original wine, there is distinct stimulation of digestive action. The retarding action is due, mainly at least, to the solid matters present in the wine, which in this particular sample amounted to 4.73 per cent. These conclusions are based upon experimental data which are seemingly quite definite. Doubtless, however, the

natural variability in the amount and character of the solid matter contained in wines of this class may lead to some variation in the extent of the influence exerted on the solvent action of the gastric juice. With clarets, on the other hand, containing approximately ten per cent. of alcohol, small amounts (say one per cent.) added to gastric juice lead to an increase in the rate of digestion. Large amounts of claret have a distinct inhibitory action which, however, is not anywhere near so pronounced as with sherry. It is true that the content of alcohol in the claret is only half that of the sherry, but even six per cent. of claret is equal to only six tenths of one per cent. of absolute alcohol. The retardation, however, produced by the presence of five per cent. of claret is approximately equivalent to that caused by five per cent. of absolute alcohol, from which it is evident that the inhibition of proteolysis produced by the presence of large amounts of claret must be due to something other than the alcohol present. This is unquestionably the solid matter and extractives present. With white wines of the hochheimer type, containing about eleven per cent. of alcohol, small quantities tend to increase the rate of pepsin-digestion, while larger amounts, say ten per cent., have a slight retarding effect which is due almost wholly to the solid matter present in the wine rather than to the alcohol or other volatile matter. Seemingly, white wines are far less active than red wines in inhibiting pepsin-proteolysis, due doubtless to the fact that they contain, as a rule, less solid matter than the red wines. That such retardation of digestive proteolysis as these various alcoholic beverages produce is due far more to the presence of extractives, etc., than to the alcohol contained in them is plainly evident from a comparison of the relative action of a given percentage (say five per cent.) of rum, whiskey, brandy, sherry, hochheimer, and claret upon the digestive action of the gastric juice. Thus, in one comparative experiment of this character, it was found that sherry, with its high content of solid matter, had the greatest retarding action, while claret came next, followed by the hochheimer. Rum, whiskey, and brandy, with the highest content of alcohol, produced the least effect. In other words, rum, whiskey, and brandy cause approximately only half the retardation of gastric proteolysis that the same percentage of claret will produce, although the latter contains only one fifth as much abso-

lute alcohol; five per cent. of absolute alcohol has no greater retarding action than the same percentage of claret with only one tenth as much alcohol.

With malt liquors, such as ale, lager beer, bock beer, stout, and porter, having a content of alcohol ranging from 1.5 to 5.5 per cent., our experiments lead to the conclusion that in small quantities they are without any inhibitory influence on the digestive power of the gastric juice; indeed, small amounts show a tendency to increase slightly the rate of digestion. In larger quantities, they give rise to an inhibition of proteolysis which is entirely unconnected with the small amounts of alcohol present, but directly traceable to the comparatively large amounts of extractives they contain. When these beverages are consumed very freely with the meals, so that the digesting mass in the stomach contains from fifty to sixty per cent. of a malt liquor, then the retarding action upon the solvent or digestive power of the gastric juice must be very considerable owing to the influence of the extractives they contain. Taken in small quantities, on the other hand, these malt liquors are without any noticeable inhibitory effect upon the proteolytic action of gastric juice. As stated in the subjoined report, such inhibitory action as these fluids possess is to be compared to the inhibitory action of such beverages as tea and coffee, the retarding action of which is equally pronounced or even greater when the latter are consumed in large quantities. It is also to be noted that the extractives or solid matters ordinarily present in malt liquors are not especially peculiar in possessing this retarding action upon pepsin-proteolysis. It is, indeed, a property shared by many substances, and does not in itself necessarily constitute an evil of any great magnitude unless the retardation is very pronounced and liable to be long continued. Then it may become a serious evil, and one sufficient to condemn the substance which causes it.

Our results and the conclusions we draw from them are in close accord with the published statements of numerous investigators in this direction. Thus, Sir William Roberts[1] found by artificial digestion experiments that in the presence of less than ten per cent. of proof spirit there was no ap-

[1] The authority for these and some of the following statements is to be found in the references on pages 251–253 of this report.

preciable retardation of gastric digestion. With twenty per cent. of proof spirit there was distinct, though slight, retardation. Klikowicz observed that five per cent. of alcohol in a digestive mixture led to somewhat variable results, although, as a rule, slight stimulation of proteolysis was observable. With whiskey, Roberts obtained results which led him to the conclusion that, "taking into account the quantity of whiskey commonly used dietetically with the meals, the amount so consumed is not sufficient to appreciably retard the speed of gastric digestion. For if the digesting mass in the stomach be estimated at two pounds, a wineglass (two ounces) of whiskey added thereto would only equal five per cent. of proof spirit (or 2.5 per cent. of absolute alcohol), an amount too small to hamper digestion to any appreciable extent." In regard to the action of wines Buchner found, in agreement with our results, that the light white and red French wines retard gastric digestion far more than corresponding quantities of alcohol, and Sir William Roberts came to the same conclusion. Writing of the dietetic use of sherry, the latter authority concludes from his experiments that "as used dietetically, sherry must figure as having frequently an important retarding effect on peptic digestion. This wine is used with dinner by some persons very freely. Half a pint of sherry is no unusual allowance, and this in a total gastric charge of two pounds amounts to about twenty-five per cent., which the table shows to be a highly inhibitory proportion. In the more common practice of taking two or three wineglasses of sherry with dinner, we see probably a double action — a stimulating action on the secretion of gastric juice and on the muscular contraction of the stomach, and a slight retarding effect on the speed of the chemical process especially in its early stages." Again, the same writer states, "If we consider the copious proportions in which hock and claret are used dietetically, it becomes evident that their retarding effect on peptic digestion is often brought into play. A pint of claret or hock is a common allowance with dinner for robust eaters — and such a proportion, as the table shows, would not be without considerable effect. . . . On the other hand, the more sparing use of these wines, a glass or two with dinner or luncheon would evidently not produce any appreciable retardation of peptic action, but

would, like corresponding doses of sherry, act as pure stimulants." With these statements our results and the conclusions we are inclined to draw from them are in close accord.

c. *Influence of alcohol and alcoholic beverages on gastric digestion as an entirety.* — From what has already been stated, it is evident that alcohol and alcoholic fluids may act directly and indirectly as stimulants to the secretion of gastric juice, and judged from this standpoint alone, their ingestion in not too large quantities must tend to accelerate the digestion of proteid foods in the stomach. Coupled with this stimulating action upon secretion, however, we find that the presence of alcoholic fluids in the stomach, especially when present in large amounts, leads to an inhibition of the chemical process of digestion, i. e., causes a retardation of the solvent action characteristic of digestion. The question therefore naturally arises, how far these two diverse effects may neutralize each other? In other words, what is the result of this divergent action upon the process of digestion as it goes on in the living stomach? In view of what has been stated regarding the rapid withdrawal of alcohol from the stomach by absorption, together with the action of the absorbed alcohol upon secretion, it would appear that the stimulating effect of alcoholic fluids upon gastric secretion would be far more lasting than the inhibitory action upon the chemical process of digestion, and thus lead to a marked increase in the rate of digestion. This point has been carefully tested by a long row of experiments upon dogs with gastric fistulæ, comparing the rate of digestion of a given test meal to which water was added, with the rate of digestion of a corresponding meal to which alcohol or some alcoholic beverage was added. The results collectively indicate that the period of gastric digestion is not greatly varied under the influence of alcohol or alcoholic beverages. In some few of the experiments, the results indicate a slight acceleration of digestion in the presence of weak alcoholic beverages, while in others strong alcohol retards slightly the rate of digestion. Giving due heed, however, to the unavoidable errors which must of necessity attend this kind of experimentation, we believe that the results obtained justify the conclusion that gastric digestion as a whole is not materially modified by the introduction of alcoholic fluids with the food. In other words, the unquestionable acceleration

of gastric secretion which follows the ingestion of alcoholic beverages is, as a rule, counterbalanced by the inhibitory effect of the alcoholic fluids upon the chemical process of gastric digestion, with perhaps at times a tendency toward preponderance of inhibitory action. The general conclusion that alcoholic beverages do not, as a rule, materially modify the ultimate result in gastric digestion is in perfect harmony with the observations of Zuntz and Magnus-Levy [1] regarding the influence of alcohol (beer) on the digestibility and utilization of food in the body. Thus it was found by these investigators, from a series of metabolic experiments on men with diets largely made up of milk and bread, and on individuals accustomed and unaccustomed to the use of alcoholic beverages, that the latter did not in any way diminish the utilization of the food by the body.

2. Salivary Digestion.

a. Influence of alcohol and alcoholic beverages on the secretion of saliva. Our experiments as to the influence of alcohol and alcoholic fluids on the secretion of mixed saliva in man and on the secretion of the submaxillary saliva in dogs lead to the following conclusions. When alcohol and alcoholic beverages are taken into the mouth, there is a direct stimulating effect upon the secretion of mixed saliva, increasing at once and in a very marked degree the flow of the secretion. This acceleration of secretion, however, is of brief duration, the influence passing off shortly after the alcoholic fluid leaves the mouth cavity. The stimulating effect of alcohol is manifested not only by an increase in the outflow of saliva, but also by an increase in the proportion of both organic and inorganic constituents, an increase in the content of alkaline-reacting salts, together with an increase in the starch-digesting power of the secretion. In other words, human mixed saliva which is secreted under the influence of an alcoholic stimulant is characterized by greater digestive power upon farinaceous foods than the fluid secreted under normal conditions. This stimulating effect is in no sense peculiar to alcohol, but is precisely analogous to the action of many so-called stimulants, such as weak acids (vinegar), ether and chloroform vapor, etc.

As stated above, the stimulating action of alcohol and alco-

[1] *Archiv f. d. ges. Physiol.*, 1891, xlix. 438 ; and 1893, liii. 544.

holic beverages upon the secretion of saliva is a direct one, produced only when the alcoholic fluid is in contact with the mouth cavity and passing off shortly thereafter. Thus, it has been found by experiment that alcoholic fluids introduced directly into the stomach in such a manner as to do away with any local action in the mouth produce no appreciable effect upon either the rate of secretion or the composition of the saliva. In other words, alcohol absorbed from the stomach and intestine into the general circulation is without influence upon the secretion of saliva; hence, as already stated, the stimulating effect of alcoholic beverages upon the secretion of saliva is of a transitory nature.

Our conclusions regarding the action of alcohol as a direct stimulant of salivary secretion receive confirmation from some recent work by Dr. Robertson,[1] of Edinburgh. This investigator states, as the result of his experiments, that "in the form of brandy or whiskey, alcohol forms a powerful stimulating agent in promoting the flow of saliva. Even in weak solution it acts energetically; but the stronger the alcohol the more powerful it is as a sialogogue." Bitter beer was also found to be a powerful sialogogue, while sherry did not appear to promote the flow of saliva, although it did produce a more abundant secretion of mucus.

b. *Influence of alcohol and alcoholic beverages on the chemical processes of salivary digestion.* In considering the influence of alcoholic beverages upon the digestion of farinaceous foods by the saliva, it is to be remembered that the normal process of salivary digestion is a comparatively short one as contrasted with the longer periods of gastric and pancreatic digestion. The amylaceous foods are exposed to the action of the saliva in the mouth for a brief period only, and although salivary digestion is without doubt continued for a short time in the stomach, yet we have every reason to believe that the active enzyme of the saliva is soon destroyed by the acidity of the gastric juice. To compensate, perhaps, for this shorter period of digestion, saliva is ordinarily very powerful in its action on starchy foods, a few minutes sufficing for the conversion

[1] W. G. A. Robertson, "The salivary digestion of starch in simple and mixed diets: An Experimental Inquiry," *Journal of Anatomy and Physiology*, 1898, vol. xxxii. p. 615.

of the available well-cooked starch into soluble products fitted for absorption. In view of these facts it is readily seen that retardation of amylolytic action may become a serious matter, and that even slight retardation of amylolysis may mean a loss of nutritive material to the body, or at least result in checking the utilization of the starchy foods until they are exposed to the action of the pancreatic juice in the small intestine.

Our experiments recorded in the subjoined report show quite conclusively that pure absolute alcohol has no very marked influence on the digestion of farinaceous foods by the saliva. With active saliva not greatly diluted the presence of even five per cent. of absolute alcohol, equivalent to about ten per cent. of proof spirit, may lead to a slight increase in digestive power. Larger quantities of alcohol cause retardation of amylolytic action, but even ten per cent. of absolute alcohol produces only slight retardation, hardly recognizable in the solvent action of the saliva, but showing in the amount of reducing sugar formed, i. e., in the secondary action of the saliva.

With strong alcoholic beverages, as whiskey and brandy, salivary digestion is not materially retarded in the presence of five per cent. of the liquors, provided the saliva is not too greatly diluted. Indeed, there may even be stimulation of amylolysis under these conditions. When, however, the saliva is greatly diluted or very weak in its amylolytic power, then retardation is noticeable even in the presence of small quantities of these alcoholic beverages. Inhibition of amylolysis in these cases, our experiments show, is out of all proportion to the contained alcohol, and is to be attributed mainly to the slight acidity of the fluids. Rum differs from whiskey and brandy in having a somewhat greater inhibitory action, due simply to the greater acidity of this fluid, and not connected with the alcohol present. Large amounts of whiskey, brandy, and rum produce marked retardation; a retardation, however, which is not closely connected with the amount of alcohol the fluids contain, but is more intimately associated with the presence of volatile, acid-reacting bodies. In conformity with this statement, we find that the solid non-volatile matters in whiskey tend to increase decidedly the starch-digesting power of saliva.

Wines, as a class, show a very powerful inhibitory influence upon salivary digestion, an influence which is due almost en-

tirely to their acid properties. Thus, when the acidity of a wine is neutralized with some alkaline fluid, it loses completely its inhibitory effect on salivary digestion. Malt liquors likewise have a very great retarding effect upon salivary digestion, especially when the saliva is quite dilute. When the saliva is less dilute, then the retarding action of the malt liquor is much less pronounced. In all cases, however, the retarding action is due almost entirely to the presence of acids or acid-reacting bodies. Consequently, as stated in the body of our report, we may conclude that the retardation of salivary digestion caused by ordinary alcoholic drinks is in character similar to the retardation which follows the use of vinegar, lemon-juice, or other acid fluids or mixtures, such as salads highly seasoned with vinegar, etc., the only difference being that the latter class are unquestionably more vigorous in their retarding action from their greater degree of acidity. We may indeed query whether under ordinary circumstances in the body the retarding action of all these fluids, alcoholic or otherwise, is quite as great as some of our experiments would at first glance indicate. It must not be overlooked that the saliva is ordinarily alkaline, and with such an alkaline fluid, aided perhaps by alkaline food, a portion, at least, of the disturbing acid of the alcoholic beverage, especially if the latter is not imbibed in too large quantity, may be neutralized and thus deterred from exercising any deleterious influence. Further, the widespread use of effervescent table waters, such as Apollinaris water and others charged with alkaline carbonates, as additions to wines of the claret and hock type, would likewise lead to a diminution of the danger in this direction. On the other hand, the acid alcoholic beverages, especially the sour wines and other liquors with pronounced acid reaction, must always be a menace to the thorough and vigorous digestion of farinaceous foods by the saliva. This obviously may be a matter of little moment to a vigorous person with abundant digestive resources, but to the weak and ailing individual with scant digestive powers it may be a matter of vital importance. The general tenor of our conclusions in this direction is in close harmony with the observations of Sir William Roberts. Thus, this investigator states that "both the stronger and the lighter wines show a powerful inhibitory effect on salivary digestion. Even so small a proportion as one

per cent. of sherry or hock was found to paralyze saliva almost completely, and even one quarter of this proportion delayed the achromatic point appreciably. Claret and port wine behaved similarly. The inhibitory effect of wines is entirely due to the very considerable degree of acidity which they all possess. . . . When the acidity of wines is neutralized they lose entirely their inhibitory effect on salivary digestion." Further, in writing of the action of malt liquors, Roberts states, as the result of his experiments, that "malt liquors were found to hamper salivary digestion exactly in proportion to their degree of acidity." Robertson,[1] in his recent work on the salivary digestion of starch, reports that "wines have a very marked inhibitory influence on the digestion of starch by saliva, and this is almost wholly due to their acidity." Alcohol, he states, even in dilute solution, "retards salivary digestion of starch, but the action is much less marked than in the case of infusions of tea." Lastly, the same author states that "beer promotes the salivary digestion of starch," a conclusion which our results hardly confirm. It should be mentioned, however, that the character of the results to be expected in experiments of this kind must of necessity be influenced by the character of the beer employed, i. e., the extent of its acidity, while the reaction of the saliva must also be taken into account.

3. Pancreatic Digestion.

While pancreatic digestion normally plays an exceedingly important part in the digestive process as a whole, the fact that the field of its operations is limited to the small intestine makes it very probable that alcoholic beverages as ordinarily consumed can exercise very little direct influence upon this phase of digestion. The main ground for this assumption lies in the fact, already explained, that alcohol is very rapidly absorbed from the alimentary tract. Indeed, as previously stated, alcohol, unlike most other substances, undergoes rapid absorption from the stomach, the results of our experiments clearly indicating that under ordinary circumstances, at least, alcoholic fluids taken by way of the mouth must lose the greater portion, if not all, of their contained alcohol before passing through the

[1] The salivary digestion of starch in simple and mixed diets: "An Experimental Inquiry," *Journal of Anatomy and Physiology*, 1898, vol. xxxii. p. 615.

pyloric orifice. Further, such portions of alcohol as may reach the small intestine must undergo rapid absorption there, while the other constituents of the alcoholic beverages must also be rapidly diminished by absorption. In view of these facts, we think it quite plain that digestion in the intestine cannot be materially affected through any direct action of alcoholic beverages. On the other hand, it is possible that pancreatic digestion may be indirectly influenced through an action of the absorbed alcohol upon the secretion of pancreatic juice and, indeed, upon the secretion of bile. This point, however, we have not attempted to determine, since there was little promise of results of any value for the present inquiry. For various reasons, however, it has seemed desirable to ascertain what effect alcoholic beverages might have, if present, upon the proteolytic action of the pancreatic juice, since this is one of the chief functions of the secretion. As to the influence of alcoholic fluids upon the *amylolytic* action of pancreatic juice there is no cause for special inquiry, since, as is well known, the amylolytic enzyme of the pancreas is essentially the same as the enzyme of saliva, hence what has been found true of the latter fluid will doubtless apply likewise to the amylolytic action of the pancreatic juice.

Influence of alcohol and alcoholic beverages on the digestion of proteid foods by pancreatic juice. The conclusions to be drawn from our experiments under this head may be briefly summarized as follows: Pancreatic juice in its proteolytic action is more sensitive to pure alcohol than gastric juice. Retardation of digestive action is more pronounced even with small amounts of alcohol, the presence of even two to three per cent. of absolute alcohol being sufficient to produce a distinct retardation of proteolysis. Still, as in the case of gastric digestion, the exact amount of retardation is greatly dependent upon the digestive power or concentration of the pancreatic fluid. When the amount of absolute alcohol present in the digestive mixture is less than one per cent., the inhibition of proteolytic action is very slight, provided the ferment or enzyme is fairly vigorous in its action.

Toward whiskey, brandy, rum, etc., the pancreatic enzyme is exceedingly sensitive, even small amounts of whiskey especially being detrimental to the digestive action of pancreatic juice on proteid foods. Further, the retarding action of a given per-

centage of whiskey is greater than that of a corresponding percentage of pure alcohol, thus indicating the presence of an additional inhibitory substance which is apparently a part of the solid matter of the whiskey and is connected in part with the acidity of the fluid. Brandy and rum likewise produce a retardation of proteolysis which is somewhat greater than that caused by a corresponding strength of alcohol.

With wines, pancreatic digestion of proteids is more strikingly inhibited than by the stronger alcoholic liquors. This action, under ordinary circumstances, is almost entirely independent of the content of alcohol and is very closely connected with the acidity of the fluid. Thus, a strongly acid wine, like a claret with only ten per cent. of alcohol, has a far greater retarding action on pancreatic proteolysis than a sherry with twice that content of alcohol, but with less acidity.

Malt liquors, as a class, likewise exert an inhibitory influence upon pancreatic proteolysis, although far less pronounced than that exerted by wines. The retarding action is due mainly to the character of the solid or extractive matters present in the liquors, and is practically unconnected with the content of alcohol. In this connection, it should be mentioned that many non-alcoholic beverages have an equally pronounced inhibitory action on pancreatic proteolysis owing to the presence of certain inorganic salts and other extractives. Tea and coffee are known to exert such an influence, while, as our experiments show, ordinary ginger ale may produce as great an inhibition of pancreatic proteolysis as a corresponding proportion of lager beer or Bass's ale.

Our general conclusions as to the action of alcohol in this direction are in close accord with the conclusions of Sir William Roberts, who has studied experimentally the effect of food accessories on pancreatic digestion. He states that "alcohol had a distinctly retarding influence when its proportion in the digesting mixture rose to five per cent. of absolute alcohol (ten per cent. of proof spirit), but the effect was comparatively slight. . . . When we consider how rapidly alcohol is absorbed from the stomach, it is obviously almost impossible that the chyme in the duodenum should ever contain anything like these proportions of alcohol, so that we may consider that alcohol as used dietetically never interferes with tryptic digestion."[1]

[1] Sir William Roberts, *Digestion and Diet*, London, 1891, p. 158.

III.

DETAILED REPORT WITH EXPERIMENTAL DATA.

The foregoing general conclusions as to the influence of alcohol and alcoholic fluids on digestion are based upon a large amount of experimental work carried out in the Laboratory of Physiological Chemistry of the Sheffield Scientific School of Yale University. The work has extended through several years, and has been rendered possible by the active coöperation of several of the writers' assistants, viz., Professor Lafayette B. Mendel, Dr. Holmes C. Jackson, and Dr. Alfred N. Richards. The experimental work has come under three distinct heads, viz.: 1. A study of the influence of alcohol and alcoholic drinks upon the chemical processes of digestion. 2. A study of the influence of alcohol and alcoholic drinks upon digestion, with special reference to secretion. 3. A study of the influence of alcoholic fluids on the composition and amylolytic power of human saliva. Since there has been much diversity of opinion as to the action of alcoholic fluids upon digestion, it has seemed wise to present all of the experimental results as well as the individual data, and the methods by which the results have been obtained, and the writer would advise all persons interested in this subject to study carefully this portion of the report as the surest way of arriving at a true comprehension of the extent to which alcohol and alcoholic fluids modify the various processes of digestion.

1. The Influence of Alcohol and Alcoholic Drinks upon the Chemical Processes of Digestion.[1]

In attempting any accurate and complete study of the influence of alcohol and alcoholic fluids upon digestion, there must be a clear recognition of the fact that no single line of experi-

[1] The experiments here reported were originally published by R. H. Chittenden and Lafayette B. Mendel in the *American Journal of the Medical Sciences*, 1896, January–April.

mentation can lead to full and concise results covering the whole ground of inquiry. For experimental purposes, therefore, the subject must be studied under several distinct heads, as (1) the influence of alcohol and alcoholic drinks upon the process of secretion; (2) upon the process of absorption; (3) upon peristalsis; and (4) upon the purely chemical processes of digestion. It is the latter phase of the subject we wish to consider now, viz.: the influence of alcohol and a variety of alcoholic drinks upon the digestive action of the several digestive fluids and their contained ferments or enzymes. Such a study cannot properly be carried out on animals nor on human beings, since it would then be almost impossible to connect the results obtained with their true cause. We must at first exclude all of the accessory influences connected with secretion, absorption, and peristalsis if we are to learn the influence of alcoholic drinks upon digestive action, and this is best done by artificial digestive experiments in which saliva, gastric juice, and pancreatic juice are allowed to act under definite and constant conditions upon the several foodstuffs, and any variations in activity carefully determined. In this way, and in this way only, in our opinion, is it possible to measure the exact influence of alcohol and alcoholic fluids upon digestive action; i. e., upon the purely chemical processes of digestion.

Before proceeding further, we would call attention to the fact that in writing this report we have confined ourselves mainly to a mere statement of the results obtained in our work, with the obvious conclusions to be drawn therefrom. In only a few instances have we attempted any comparison with the results obtained by other workers in this direction, and, as a rule, we have refrained from generalizations other than those plainly warranted by the data which we ourselves have obtained. At the end of the report a short bibliography is appended giving the more important papers by previous workers.

A. GASTRIC DIGESTION (I. E. PROTEOLYSIS BY PEPSIN-HYDROCHLORIC ACID).

The solvent action of gastric juice on proteid or albuminous foods is due solely to the presence of pepsin-hydrochloric acid, but the amount of both pepsin and acid in the natural secretion varies considerably with different states of the system.

The average amount of hydrochloric acid, however, is approximately 0.2 per cent., while to the pepsin no definite figure can be given, since as yet the chemist has not been able to isolate the ferment in a pure state. Further, it is quite certain that both ferment and acid are subject to great variation in the amount present in the secretion at different stages of digestion and under different conditions of health and nutrition. In view of these facts we have experimented under varying conditions in order that our results may have as wide an application as possible.

The methods pursued were as follows: —

(*a*) *With fluid egg-albumin.*[1] The albumin solution was prepared after the method recommended by Schütz.[2] A quantity of undiluted white of egg was freed from globulin by the addition of hydrochloric acid of specific gravity 1.12 (4.2 c. c. acid to 300 c. c. of albumin), the mixture shaken vigorously, and after standing some hours filtered through paper. The clear acid fluid was then made exactly neutral with dilute sodium carbonate, after which it is ready for use. Ten c. c. of this fluid contain a little less than one gram of coagulable proteid, the exact amount being determined by heat-precipitation, collecting the coagulum on a weighed filter and drying at 110° C.

The digestive experiments were made in series, each individual mixture containing the same volume of the prepared albumin solution (10–20 c. c.), together with the same amount of pepsin and acid. The albumin solution was introduced into a small flask of 200 c. c. capacity provided with a suitable stopper, water and alcohol, or alcoholic fluid, being added to make the volume up to 50 c. c.

Lastly, 50 c. c. of 0.4 per cent. hydrochloric acid, containing a known amount of pepsin, were added, making the total volume of each mixture 100 c. c., and the strength of acid 0.2 per cent. HCl. It is thus evident that the only variable element in the mixtures of a given series is the amount of alcohol or alcoholic fluid present. The flasks were then placed in a water-bath, kept approximately at the body temperature (38–40° C.) for a definite period — usually five to seven hours. At

[1] See R. H. Chittenden, "Observations on the Digestive Ferments," *Medical News*, Philadelphia, February 16, 1889.

[2] *Zeitschr. f. physiol. Chem.*, ix. 581.

the end of the allotted time, the extent of digestive action was determined by simply heating the mixtures to boiling, neutralizing the acid fluid by addition of an equivalent amount of sodium carbonate in a one per cent. solution, and collecting the precipitate of unaltered albumin or acid-albumin on a weighed filter, washing it with boiling water until free from chlorides, and then drying at 110° C. until of constant weight. The difference between the weight of coagulable albumin introduced and the amount found at the end of the experiment gives the amount of soluble digestive products, i. e., albumoses and peptones, formed under the conditions of the experiment. In this way it is possible to measure accurately the extent of proteolytic action under varying conditions.

(*b*) *With coagulated blood-fibrin.* Fresh blood-fibrin from the blood of oxen or sheep was washed with water until quite white, then boiled repeatedly with water, after which it was thoroughly extracted with cold alcohol, boiling alcohol, and, lastly, with ether. It was then ground to a coarse powder and passed through a sieve, so constructed that the particles collected were all approximately of the same size. The so prepared powder was then dried at 110° C. until of constant weight.

The digestive experiments with this form of proteid matter were conducted as follows: A definite amount of alcohol or alcoholic fluid was introduced into each flask, water being added to make the volume 50 c. c. Then 50 c. c. of 0.4 per cent. hydrochloric acid containing a known amount of pepsin were added, thus making the total volume of fluid 100 c. c. To this mixture two grams of the prepared fibrin were added. Thus, as in the experiments with fluid egg-albumin, all of the mixtures of a given series were exactly alike in containing the same volume of 0.2 per cent. hydrochloric acid, the same amount of pepsin, etc., but unlike in the percentage of alcohol or alcoholic fluid present. For comparison, one mixture of each series contained no alcohol whatever. When prepared, the mixtures of a given series were placed in a bath at 38°–40° C. for two to three hours, where they were kept under exactly the same conditions, being stirred or shaken to the same extent, etc. At the end of the given period the mixtures were heated to boiling to destroy the ferment, after which the undigested residue was collected on a weighed filter, washed with boiling water until free from all

soluble matter, then dried at 110° C. until of constant weight. The difference between the weight of the fibrin taken and the undissolved residue is a true measure of the digestive action under the conditions of the experiment.

Action of Absolute Alcohol (99.5–100 per cent.).

The percentages of alcohol referred to are percentages by volume unless otherwise specified. The pepsin employed was a very active scale pepsin marked 1 : 4000.

Experiment 1.

Conditions:

Proteid = fluid egg-albumin (20 c. c.).
20 c. c. albumin solution contain 1.6398 grams dry albumin.
0.03 gram pepsin ; 0.2 per cent. hydrochloric acid.
Period of digestion $6\frac{1}{12}$ hours at 38°–40° C.

Alcohol.	Undigested albumin.	Proteid digested.	Relative proteolytic action.[1]
0 per cent.	0.1850 gram.	88.8 per cent.	100.0
6 "	0.2708 "	83.5 "	94.0
12 "	0.5473 "	66.7 "	76.0
18 "	0.6703 "	59.2 "	66.6

Experiment 2.

Conditions:

Proteid = fluid egg-albumin (15 c. c.).
15 c. c. albumin solution contain 1.0522 grams dry albumin.
0.0024 gram pepsin; 0.2 per cent. hydrochlorie acid.
Period of digestion $5\frac{1}{3}$ hours at 38°–40° C.

Alcohol.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4007 gram.	62.0 per cent.	100.0
1 "	0.4075 "	61.3 "	98.8
3 "	0.5146 "	51.1 "	82.4
6 "	0.6256 "	40.6 "	65.4

Experiment 3.

Conditions:

Proteid = fluid egg-albumin (10 c. c.).
10 c. c. albumin solution contain 0.8199 gram dry albumin.
0.03 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $5\frac{1}{6}$ hours at 38°–40° C.

[1] Expressing the relative extent of digestive action as compared with the action of the control experiment, the latter being taken as 100.

Alcohol.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	trace	100.0 per cent.	100.0
1 "	0.0100 gram.	98.8 "	98.8
3 "	0.0130 "	98.5 "	98.5
5 "	0.0250 "	97.0 "	97.0
8 "	0.0699 "	91.5 "	91.5
10 "	0.0875 "	89.4 "	89.4

Experiment 4.

Conditions :

Proteid = fluid egg-albumin (20 c. c.).
20 c. c. albumin solution contain 1.9198 grams dry albumin.
0.05 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $5\frac{1}{2}$ hours at 38°–40° C.

Alcohol.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.0887 gram.	95.4 per cent.	100.0
1 "	0.0740 "	96.1 "	100.8
5 "	0.2617 "	86.4 "	90.5
10 "	0.5373 "	72.0 "	75.5
15 "	0.5859 "	69.5 "	72.8

Experiment 5.

Conditions :

Proteid = blood-fibrin (2 grams).
0.016 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $2\frac{1}{4}$ hours at 38°–40° C.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5834 gram.	70.9 per cent.	100.0
1 "	0.5727 "	71.4 "	100.7
3 "	0.6273 "	68.7 "	96.8
5 "	0.6493 "	67.6 "	95.3

The following five series of experiments were all made after the same plan, each mixture containing 2 grams of blood-fibrin, 0.016 gram pepsin in 0.2 per cent. hydrochloric acid, and warmed at 38°–40° C. for $2\frac{1}{4}$ hours : —

Experiment 6.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3676 gram.	81.7 per cent.	100.0
10 "	0.5970[1] "	70.2 "	85.9

[1] Filtered very slowly and could not be washed thoroughly ; hence, the result is only approximately correct.

Experiment 7.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2013 gram.	90.0 per cent.	100.0
5 "	0.2601 "	87.0 "	96.6

Experiment 8.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1759 gram.	91.3 per cent.	100.0
5 "	0.2145 "	89.3 "	97.8

Experiment 9.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2027 gram.	89.9 per cent.	100.0
5 "	0.2619 "	87.0 "	96.7

Experiment 10.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3881 gram.	80.6 per cent.	100.0
4 "	0.4118 "	79.5 "	98.6

In the following three experiments the conditions were the same as in the preceding, excepting that the mixtures were warmed at 38°–40° C. for 2 hours instead of 2¼ hours: —

Experiment 11.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5315 gram.	73.5 per cent.	100.0
2 "	0.5390 "	73.1 "	99.4

Experiment 12.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4630 gram.	76.9 per cent.	100.0
2 "	0.4583 "	77.1 "	100.2

Experiment 13.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1970 gram.	90.2 per cent.	100.0
5 "	0.2830 "	85.9 "	95.2

In the following three experiments the conditions were the same as in the preceding, except that the mixtures were warmed at 38°–40° C. for 1¾ hours: —

Experiment 14.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5068 gram.	74.7 per cent.	100.0
2 "	0.4970 "	75.2 "	100.6

Experiment 15.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2032 gram.	89.9 per cent.	100.0
5 "	0.2317 "	88.5 "	98.4

Experiment 16.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3247 gram.	83.8 per cent.	100.0
5 "	0.3554 "	82.3 "	98.2

In the following two experiments the mixtures were warmed at 38°–40° C. for 1½ hours: —

Experiment 17.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3361 gram.	83.2 per cent.	100.0
5 "	0.4040 "	79.8 "	95.9

Experiment 18.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3867 gram.	80.7 per cent.	100.0
5 "	0.4352 "	78.3 "	97.0

In the following experiment the conditions were apparently much the same as in the preceding experiments, although the results show a greater degree of retardation with like percentages of alcohol: —

Experiment 19.

Conditions: —

Proteid = blood-fibrin (2 grams).
0.02 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 2¼ hours at 38°–40° C.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4536 gram.	77.32 per cent.	100.0
0.5 "	0.4688 "	76.56 "	99.0
1.0 "	0.4954 "	75.23 "	97.2
2.0 "	0.4958 "	75.21 "	97.2
3.0 "	0.5324 "	73.38 "	94.9
5.0 "	0.6031 "	69.84 "	90.3

A careful study of all the preceding results makes it evident that we cannot define with mathematical exactness the action of a given percentage of absolute alcohol on pepsin-proteolysis, since variations in the attendant conditions, i. e., the relative amounts of pepsin, acid, and proteid, together with the period

of digestion, the digestibility of the particular proteid, etc., are prone to modify the final result. Thus, with a weak gastric juice, where the amount of ferment present is small and digestive action consequently slow, or where the proteid material used is difficult of digestion, the retarding effect of a given percentage of alcohol is far greater than when the digestive fluid is more active; that is, when it contains more pepsin. (Contrast Experiments 1, 2, and 3.) Further, this difference of action is more pronounced the larger the percentage of alcohol present. Thus, in Experiments 2 and 3, where the difference in the amount of pepsin present is very great, the action of one per cent. of absolute alcohol is essentially the same; but when the amount of alcohol is raised to three, five, or six per cent., then the difference in digestive action is very striking.

Bearing in mind the possibility of these variations incidental to variations in the attendant conditions, and recognizing the possibility and probability of just such variations in the human stomach, we may look at our results with a view to drawing some general conclusions. First, it is plainly manifest that in the presence of small amounts of alcohol (from one to two per cent. of absolute alcohol) gastric digestion may proceed as well or even better than under normal circumstances. In fact, many of our experiments show a slight increase in digestive power when the mixture contains one or two per cent. of absolute alcohol. This increased digestive action, though slight, occurs too frequently to be the result of mere accident, and apparently indicates a tendency for alcohol, when present in small quantity, to increase slightly the digestive action of pepsin-hydrochloric acid; or, in other words, to so stimulate the ferment that it can accomplish somewhat more, under given conditions, than it otherwise could do. As the percentage of alcohol is raised, retardation or inhibition becomes more noticeable, although ordinarily it is not very pronounced until the digestive mixture contains five to ten per cent. or more of absolute alcohol. With from fifteen to eighteen per cent. of absolute alcohol, digestive action may be reduced one quarter or even one third, the exact amount of retardation, however, being especially dependent upon the strength or activity of the gastric juice and upon the natural digestibility of the proteid material. (See

Experiments 1, 3, 4, and 6.) It is to be remembered, however, that eighteen per cent. of absolute alcohol would be equivalent to thirty-six per cent. of proof spirit, so that if we should assume the contents of a human stomach at a given period to be one third proof spirit, it might perhaps be considered that digestive action would be retarded to the extent of from twenty-five to thirty-five per cent., provided the gastric juice present in the stomach was of fair strength and the proteid matter of ordinary digestibility. Such percentages of proof-spirit, however, are not likely to be long present in the stomach, and it is perhaps idle to speculate on such hypothetical cases. We may in this connection, however, again emphasize the fact that the stronger the gastric juice and the more digestible the proteid food undergoing digestion the less retardation will a given percentage of alcohol produce, while, on the other hand, the weaker the gastric juice and the more indigestible the proteid the greater will be the inhibition caused by a given percentage of alcohol. In other words, those variations which must naturally exist in the stomach-contents of different individuals, both in health and disease, will lead to different degrees of retardation in the presence of given percentages of absolute alcohol. It would, therefore, be unwise to make a general specific statement regarding the action of a given percentage of alcohol. Under definite conditions, however, as our experiments plainly show, the presence of a definite amount of alcohol always leads to essentially the same results.

In order to prevent any misinterpretation of these results, we would again call attention to the fact that we are dealing here with only one of the four questions that need to be answered before we can hope to fully understand the influence of alcohol on gastric digestion as a whole. Thus, our results afford plain evidence of the influence of alcohol on the digestive or solvent power of the gastric juice, but we should not be justified in arguing that exactly the same results would follow from the introduction of alcohol into the living stomach. The action of a given percentage of alcohol on proteolysis alone would be essentially the same in the stomach as in a beaker, provided the alcohol was not absorbed into the blood and thus removed from contact with the digestive mixture, and provided it did not exert any influence on the character of the gastric juice secreted.

But it is easily conceivable that a percentage of alcohol which does not interfere with solution of the proteid foodstuffs may so modify the amount or character of the secretion that digestion might be greatly stimulated or greatly retarded. Further, as already stated, the presence of alcohol in the stomach may so affect absorption and peristalsis that the rate of digestion may be modified from these causes: hence, the results above recorded are to be used only in drawing conclusions as to the effect of various percentages of alcohol on the purely chemical process of gastric digestion, i. e., on pepsin-proteolysis.

In conclusion, it is to be noted that our results are more or less in accord with what has been previously published concerning the action of alcohol on gastric digestion. Thus, Bikfalvi [1] found in artificial digestive experiments that alcohol, even in small quantities, retards normal gastric digestion. Klikowicz [2] found that the presence of five per cent. of alcohol in the digestion of egg and serum-albumin led to somewhat variable results, although, as a rule, there was an indication of a slight stimulation of proteolytic action. In the presence of ten per cent. of alcohol there was always marked retardation, while fifteen, twenty, and thirty per cent. of alcohol checked digestion to a marked degree.

Roberts found by artificial digestion-experiments that in the presence of less than ten per cent. of proof spirit there was no appreciable retardation. With ten per cent., retardation was only barely detectable. With twenty per cent., there was quite distinct, but still only a slight, retardation. Above this point, however, the inhibitory effect of alcohol increased rapidly.[3]

That the action of a digestive ferment may be both stimulated and retarded by the same substance, according to the quantity present, has been already demonstrated;[4] hence there is no inconsistency in the above results with alcohol. The same action has likewise been observed with yeast-cells.[5]

[1] *Jahresbericht für Thierchemie*, xv. 273.

[2] *Virchow's Archiv*, cii. 376.

[3] *Digestion and Diet*, p. 132.

[4] Chittenden, *Studies in Physiological Chemistry*, Yale Univer., vol. i. p. 76; also vol. iii. p. 60. Dubs, *Virchow's Archiv*, cxxxiv. 519–540.

[5] Schultz, *Pflüger's Archiv*, xlii. 517. Biernacki, *Jahresbericht für Thierchemie*, xvii. 477.

Action of Whiskey.

Pure whiskey, as is well known, is simply "a diluted alcohol with a peculiar flavor or aroma, due to the raw material employed in its manufacture, and developed during the fermentation, distillation, and aging of the liquor."[1]

Analysis of a large number of samples of whiskey made under the direction of the New York State Board of Health[2] has shown that adulteration is limited mainly to the addition of water and coloring matter, while such deleterious substances as fusel oils may be present in liquors which have not been properly rectified. Thus, the percentage of alcohol was found to vary from 28.9 per cent. by volume to 60.3 per cent. By far the larger number of samples analyzed showed a content of alcohol ranging from thirty five to forty per cent. by volume.

Our work on the influence of whiskey on gastric digestion was commenced by studying the influence of a medium quality of rye whiskey (Mount Vernon pure rye whiskey, one dollar per quart), analysis of which gave the following results: —

Specific gravity	0.937 at 17.5° C.
Alcohol, by volume	50–51 per cent.[3]
Solid residue at 110° C.	0.3284 gram per 100 c. c.
Ash	0.0040 " " "
Reaction acid.	

Experiment 20.

Conditions:

Proteid = fluid egg-albumin (10 c. c.).
10 c. c. albumin solution contain 0.8146 gram dry albumin.
0.03 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $4\frac{1}{2}$ hours at 38°–40° C.

Whiskey.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.0182 gram.	97.8 per cent.	100.0
3 "	0.0176 "	97.9 "	100.1
5 "	0.0288 "	96.6 "	98.7
8 "	0.0284 "	96.6 "	98.7
10 "	0.0384 "	95.3 "	97.4

[1] *Second Annual Report of the New York State Board of Health*, p. 642.
[2] *Loc. cit.*, pp. 647, 648.
[3] Varying somewhat in different samples.

Experiment 21.

Conditions :

Proteid = fluid egg-albumin (10 c. c.).

10 c. c. albumin solution contain 0.8146 gram dry albumin.

0.012 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion 6 hours at 38°–40° C.

Whiskey.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.0270 gram.	96.7 per cent.	100.0
1 "	0.0231 "	97.2 "	100.5
3 "	0.0333 "	96.0 "	99.2
5 "	0.0395 "	95.2 "	98.4
8 "	0.0616 "	92.5 "	95.6
10 "	0.0774 "	90.5 "	93.5

Experiment 22.

Conditions :

Proteid = fluid egg-albumin (15 c. c.).

15 c. c. albumin solution contain 1.0522 grams dry albumin.

0.0024 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion $5\frac{1}{3}$ hours at 38°–40° C.

Whiskey.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4007 gram.	62.0 per cent.	100.0
1 "	0.4263 "	59.5 "	95.9
3 "	0.4545 "	56.9 "	91.7
6 "	0.5372 "	49.0 "	79.0
Absolute alcohol.			
3 per cent.	0.5146 "	51.1 "	82.4

Experiment 23.

Conditions :

Proteid = blood-fibrin (2 grams).

0.016 gram pepsin ; 0.2 per cent hydrochloric acid.

Period of digestion $2\frac{5}{6}$ hours at 38°–40° C.

Whiskey.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3401 gram.	83.0 per cent.	100.0
1 "	0.3357 "	83.3 "	100.3
3 "	0.3401 "	83.0 "	100.0
6 "	0.3678 "	81.7 "	98.4

Experiment 24.

Conditions the same as in the preceding experiment :

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2013 gram	90.0 per cent.	100.0
5 " absol. alcoh.	0.2601 "	87.0 "	96.6
5 " whiskey	0.2312 "	88.5 "	98.3

In the following experiment six different samples of whiskey were employed, several of which were known to contain only forty per cent. of alcohol, and their action contrasted with half the percentage of absolute alcohol: —

Experiment 25.

Conditions:

Proteid = blood-fibrin (2 grams).

0.009 gram pepsin; 0.2 per cent. hydrochloric acid.

Period of digestion $1\frac{1}{12}$ hours at 38°–40° C.

Whiskey.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.6701 gram.	66.5 per cent.	100.0
20 "	0.9659 "	51.8 "	77.8
20 "	0.9849 "	50.8 "	76.3
20 "	1.0378 "	48.2 "	72.4
20 "	1.0156 "	49.3 "	74.1
20 "	1.0390 "	48.1 "	72.3
20 "	1.0735 "	46.4 "	69.7
Absolute alcohol. 10 per cent.	1.0673 "	46.7 "	70.2

It is thus evident from these experiments that when digestive action is fairly vigorous, as in the presence of moderate amounts of pepsin (Experiments 20, 21, and 23), small percentages of whiskey have no retarding action whatever upon gastric digestion; indeed, there is even a slight suggestion of increased digestive action in the presence of from one to three per cent. of whiskey, much the same as was observed in the experiments with absolute alcohol. In the presence of twenty per cent. of whiskey digestive activity may be reduced one fourth. Further, the retardation which is produced by larger percentages of whiskey is approximately equal to the retarding action caused by half these percentages of absolute alcohol. In other words, the results would seemingly point to the contained alcohol as the main cause of the inhibition produced by the whiskey. In Experiment 22 we again have evidence of the greater retarding effect of both whiskey and alcohol when the gastric juice is weak, owing to the presence of a small amount of pepsin.

In order to determine more definitely the exact cause of the inhibitory action of whiskey on gastric digestion the following experiments were tried: —

Experiment 26.

Conditions :

Proteid = fluid egg-albumin (15 c. c.).

15 c. c. albumin solution contain 1.0522 grams dry albumin.

0.0024 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion $5\frac{2}{3}$ hours at 38°–40° C.

Whiskey.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5065 gram.	51.9 per cent.	100.0
1 "	0.5268 "	50.0 "	96.3
3 "	0.5496 "	47.8 "	92.1
6 "	0.6069 "	42.4 "	81.6
Whiskey residue.[1]			
1 per cent.	0.5105 "	51.5 "	99.2
6 "	0.4719 "	55.2 "	106.3

Experiment 27.

Conditions the same as in Experiment 25, except that the 15 c. c. of albumin solution contained 1.2219 grams of dry albumin, and the period of digestion was $4\frac{1}{12}$ hours: —

Whiskey.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5552 gram.	54.6 per cent.	100.0
1 "	0.6239 "	49.0 "	89.7
3 "	0.6573 "	46.2 "	84.6
6 "	0.6883 "	43.7 "	80.0
9 "	0.7457 "	39.0 "	71.4
Whiskey residue.			
1 per cent.	0.5559 "	54.6 "	100.0
6 "	0.5705 "	53.4 "	97.8

Experiment 28.

Conditions :

Proteid = blood-fibrin (2 grams).

0.016 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion, $2\frac{1}{4}$ hours at 38°–40° C.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1759 gram.	91.3 per cent.	100.0
5 " absol. alcoh.	0.2145 "	89.3 "	97.8
5 " whiskey residue	0.1847 "	90.8 "	99.4

[1] The whiskey residue was prepared by simply concentrating a definite volume of whiskey on the water-bath until the alcohol and volatile matter were driven off, then making the residue up to the original volume with water. Hence, one per cent. residue means the residue contained in one per cent. of whiskey.

Experiment 29.

Conditions the same as in the preceding experiment, except that the period of digestion was $1\frac{3}{4}$ hours:—

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2032 gram.	89.9 per cent.	100.0
5 " alcohol	0.2317 "	88.5 "	98.4
10 " whiskey	0.2181 "	89.1 "	99.1
10 " " distil.[1]	0.2499 "	87.6 "	97.4
10 " " residue	0.2002 "	90.0 "	100.1

Experiment 30.

Conditions the same as in the preceding experiment, except that the period of digestion was two hours:—

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1970 gram.	90.2 per cent.	100.0
5 " alcohol	0.2830 "	85.9 "	95.2
10 " whiskey	0.3056 "	84.8 "	94.0
10 " " distil.	0.2336 "	88.4 "	98.0
10 " " residue	0.2027 "	89.9 "	99.6

Experiment 31.

Conditions the same as in the preceding experiment, except that the period of digestion was $1\frac{5}{12}$ hours:—

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3867 gram.	80.7 per cent.	100.0
5 " absol. alcoh.	0.4352 "	78.3 "	97.0
10 " whiskey	0.4481 "	77.6 "	96.1
10 " " distil.	0.4274 "	78.7 "	97.5
10 " " residue dissolved in water	0.4968 "	75.2 "	93.1
10 per cent. residue dissolved in alcohol[2]	0.3604 "	82.0 "	101.6

If the detailed results obtained in these many experiments are carefully scrutinized it will be seen that the small amount of solid matter contained in whiskey — the so-called whiskey

[1] The "whiskey distillate" was prepared by distilling a definite volume of whiskey nearly to dryness and making the distillate up to the original volume with water, the ten per cent. whiskey distillate, therefore, meaning the volatile matter contained in that specific volume of whiskey.

[2] The whiskey residue obtained as already described, but dissolved in alcohol of the strength originally present in the whiskey instead of in water.

residue — has in the majority of cases little or no retarding action on gastric digestion. That there should be some variation is to be expected, owing to possible variations in the amount and character of this solid matter. Further, the residue obtained by evaporation of whiskey is not always completely soluble in water, and the action of this material may naturally be somewhat different when mixed with water than when dissolved in alcohol (see Experiment 31). Still the general conclusion seems to be warranted that, as a rule, the solid matter of the whiskey is not responsible for the retarding action of this fluid upon the chemical process of gastric digestion. Such action as the whiskey possesses is to be attributed mainly to the alcohol or other volatile matter it contains. At the same time it is to be noted that with a fairly active gastric juice (Experiments 29, 30, and 31), the amount of retardation even with ten per cent. of whiskey is not great, any more than it is in the presence of five per cent. of absolute alcohol. When, however, the gastric juice is very weak from scarcity of the active ferment, as in Experiments 26 and 27, then even small amounts of whiskey exercise a very marked retarding effect upon the digestive process. Further, these two experiments plainly show that the retardation in these cases is due essentially to the volatile matter of the whiskey, and not to the solid matter contained in it. We may thus conclude, with Roberts,[1] that taking into account the quantity of whiskey commonly used dietetically with meals, the amount so consumed is not sufficient to appreciably retard the speed of gastric digestion. For, if the digesting mass in the stomach be estimated at two pounds, a wineglass (two ounces) of whiskey added thereto would only equal five per cent. of proof spirit (or 2.5 per cent. of absolute alcohol) an amount too small to hamper digestion to any appreciable extent. Even double such an amount, as Roberts says, would scarcely have any marked retarding effect upon pepsin-proteolysis. Hence, whiskey can be considered to impede the solvent action of the gastric juice only when taken immoderately and in intoxicating quantities.

So much has been said and written about the widespread adulteration and falsification of whiskeys that we deemed it wise before leaving the subject to make a search for samples of

[1] *Digestion and Diet*, p. 133.

this liquor which would show a wide variation from what might be called the normal standard. The results thus far reported were obtained with whiskeys containing fifty per cent. of alcohol by volume. Professor James Babcock, in his first and second annual report as assayer of liquors to the commonwealth of Massachusetts, gives the strength of 257 samples of ordinary whiskey analyzed by him as varying from thirty to fifty-nine per cent. of alcohol by volume. The few samples that we have purchased in New Haven and analyzed, however, have, with one or two exceptions, shown very little difference in their content of alcohol, although we took particular pains to obtain them from representative places. The character of these places may be indicated by their names.

	Alcohol.
Sample A, from high-class grocer	50 per cent.
" B, " Canadian Club whiskey	42 "
" C, " saloon of better class	40 "
" D, " " of low order	44 "
" E, " " of low order	43 "
" F, " " known as the "dead-house" .	42 "
" G, " " known as "Sneezer's" . .	40 "
" H, " " quite respectable	40 "
" I, " " McGraw's	30 "

With the exception of the first and last of these few samples there is very little variation in the content of alcohol. Digestion experiments tried with some of these whiskeys gave the following results: —

Experiment 32.

Conditions:

Proteid = blood-fibrin (2 grams).
0.015 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $1\frac{1}{4}$ hours at 38°–40° C.

Whiskey.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.6131 gram.	69.4 per cent.	100.0
Sample I, 10 "	0.6591 "	67.1 "	96.6
" B, 10 "	0.6876 "	65.7 "	94.6
" G, 10 "	0.7469 "	62.7 "	90.3

Experiment 33.

Conditions practically the same as in the preceding experiment: —

Fluid added.		Undigested fibrin.	Proteid digested.	Relative proteolytic action.
	0 per cent.	0.5945 gram.	70.3 per cent.	100.0
Whiskey D, 10	"	0.7711 "	64.5 "	91.7
" C, 10	"	0.7352 "	63.3 "	90.0
" F, 10	"	0.7609 "	62.0 "	88.1
" E, 10	"	0.8086 "	59.6 "	84.7
" H, 10	"	0.8659 "	56.8 "	80.7
Absol. alcoh. 5	"	0.8362 "	58.2 "	82.7

If we compare the action of these samples of whiskeys, we see (Experiment 32) that sample I, with the lowest content of alcohol, has the least inhibitory effect. On the other hand, in Experiment 33 there are greater differences in the retardation produced by these several varieties of whiskey than one would expect from the slight variations in the content of alcohol. This, however, we are inclined to attribute, in part at least, to the presence of variable amounts of tannin. In accordance with this idea, we found that among those samples with a like content of alcohol the presence of tannin was more conspicuous in the whiskeys with the greatest retarding action.

Action of So-called Fusel Oils on Gastric Digestion.

So much has been written concerning the contamination of whiskeys and other liquors with fusel oil that we deemed it wise to give some thought to this matter in connection with our study of the influence of whiskey, brandy, and other liquors on the chemical processes of gastric digestion. It is a well-known fact that when fermented saccharine liquors are submitted to distillation there are obtained, in addition to water and ordinary or ethyl alcohol, small quantities of other alcohols, which are commonly known as fusel oil. Each raw material used in the preparation of a distilled liquor is supposed to have its own particular form of fusel oil. Hence, there is the potato fusel oil, sugar-beet fusel oil, rye fusel oil, corn fusel oil, grape fusel oil, etc., which contain in various proportions propyl, butyl, amyl alcohol, etc. Of these alcohols, amyl alcohol is said to be the most poisonous, and it is generally understood to be present in largest quantity in the whiskeys made from the potato. However this may be, the various constituents of these fusel oils react upon each other during the process of aging, forming new and more volatile combinations which help give to the respective fluids their aroma and bouquet. Hence, in old whis-

keys fusel oils should be entirely absent, and in all properly distilled and rectified spirits the amount of these substances should be at the most quite small. Indeed, so far as our own experience goes, we have never found more than traces of these so-called oils in the whiskeys or brandies that we have examined. But with a view to ascertaining the effect of such substances on gastric digestion, assuming them to be present in whiskeys and other like liquors, we have tried some experiments with the alcohols of this class, in order to ascertain how their possible presence would influence the chemical processes of digestion. The results may be briefly detailed in the following experiments:[1] —

Experiment 34.

Conditions:

Proteid = blood-fibrin (2 grams).
0.02 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 2 hours at 38°–40° C.

Amyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5665 gram.	71.6 per cent.	100.0
0.10 "	0.5316 "	73.4 "	102.4
0.25 "	0.6176 "	69.1 "	96.4
0.50 "	0.6179 "	69.1 "	96.4
1.00 "	0.6887 "	65.5 "	91.4
2.00 "	0.8801 "	55.9 "	78.1

Experiment 35.

Conditions the same as in the preceding experiments, except that the period of digestion was $1\frac{5}{6}$ hours: —

Isobutyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.7225 gram.	63.8 per cent.	100.0
0.05 "	0.6580 "	67.1 "	105.0
0.10 "	0.7583 "	62.0 "	97.1
0.25 "	0.7993 "	60.0 "	93.9
0.50 "	0.8313 "	58.4 "	91.4
2.00 "	0.8451 "	57.7 "	90.4

[1] These experiments were carried out in our laboratory by Richard F. Rand, Ph. B.

Experiment 36.

Conditions the same as in the preceding experiment: —

Propyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.6136 gram.	69.3 per cent.	100.0
0.05 "	0.5514 "	72.4 "	104.4
0.10 "	0.5025 "	74.8 "	108.0
0.25 "	0.4944 "	75.2 "	108.5
0.50 "	0.5872 "	70.6 "	101.9
2.00 "	0.6192 "	69.0 "	99.5

Larger percentages of propyl alcohol gave the following results, the conditions being the same as in the preceding experiment, except that the period of digestion was $2\frac{1}{4}$ hours: —

Propyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5323 gram.	73.3 per cent.	100.0
5 "	0.7804 "	60.9 "	82.1
10 "	1.6271 "	18.6 "	24.0
15 "	1.8829 "	5.8 "	9.0
20 "	1.9047 "	4.7 "	6.4

Experiment 37.

Conditions the same as in the preceding experiments, save that the period of digestion was $2\frac{1}{4}$ hours: —

Methyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4892 gram.	75.5 per cent.	100.0
0.5 "	0.4492 "	77.5 "	102.6
2.0 "	0.4325 "	78.3 "	103.7
3.0 "	0.5381 "	73.0 "	96.7
5.0 "	0.5333 "	73.3 "	97.0

When it is remembered that these alcohols, if present at all, are found in whiskeys and similar liquors only in small quantities — hardly more than traces — it is seen that their action on the chemical processes of gastric digestion cannot be very deleterious. Indeed, so far as our data show, the presence of traces of these alcohols tends to increase rather than to decrease the rate of digestive action. While they may be very undesirable impurities in alcoholic liquors, and may perhaps have many physiological properties detrimental to health, they certainly do not materially interfere with the chemical processes of gastric digestion. Physiologically, it is of interest to note how all of these alcohols, as well as ethyl alcohol, have the property

of increasing the rate of digestive action when present in small amount. Also noticeable is the relationship between the position of the alcohol in the series and the extent of its stimulating and retarding action. Thus, methyl alcohol, the lowest member of the series, increases the rate of proteolysis even when present to the extent of two per cent., while amyl alcohol produces stimulation only when present in amounts less than 0.2 per cent.

Brandy.

According to Dr. Edward Smith of England, "brandy is, or should be, the choicest and most agreeable member of the class of ardent spirits. It should be prepared by distillation from wine," but, as is well known, a large amount of the brandy consumed at the present time is simply alcohol distilled as in the preparation of whiskey, and flavored with oil of cognac. From this it may be inferred that brandy will have much the same action as whiskey on gastric digestion.

The brandy used in our first experiments was of good quality, known as Horne's cold distilled brandy, selling at $1.25 per quart. Analysis showed the following composition : —

Specific gravity	0.940 (at 19° C.).
Alcohol by volume	47–48 per cent.
Solid residue at 110° C. . . .	0.0430 gram per 100 c. c.
Ash	0.0054 " " "
Reaction acid.	

Experiment 38.

Conditions :

Proteid = fluid egg-albumin (15 c. c.).
15 c. c. albumin solution contain 1.3395 grams dry albumin.
0.006 gram pepsin ; 0.2 per cent. hydrochloric acid.
Period of digestion 7 hours at 38°–40° C.

Brandy.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3962 gram.	70.5 per cent.	100.0
1 "	0.4379 "	67.4 "	95.6
3 "	0.5012 "	62.8 "	89.0
6 "	0.5218 "	61.1 "	66.6
Brandy residue.			
1 per cent.	0.3992 "	70.2 "	99.4
6 "	0.3654 "	72.8 "	103.2

Experiment 39.

Conditions :

Proteid = blood-fibrin (2 grams).

0.016 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion $2\frac{5}{6}$ hours at 38°–40° C.

Brandy.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3401 gram.	83.0 per cent.	100.0
1 "	0.3306 "	83.5 "	100.6
3 "	0.3440 "	82.8 "	99.7
6 "	0.3433 "	82.9 "	99.8

Experiment 40.

Conditions the same as in the preceding experiment, except that the period of digestion was $2\frac{1}{4}$ hours : —

Brandy.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2013 gram.	90.0 per cent.	100.0
5 "	0.2251 "	88.8 "	98.7

Experiment 41.

Conditions the same as the above, except that the period of digestion was $1\frac{7}{12}$ hours : —

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3247 gram.	83.8 per cent.	100.0
5 " absol. alcoh.	0.3554 "	82.3 "	98.2
10 " brandy	0.3752 "	81.3 "	97.0
10 " " distil.	0.3489 "	82.6 "	98.5
10 " " residue [1]	0.3024 "	84.9 "	101.3

Experiment 42.

Conditions the same as the above, except that the period of digestion was $1\frac{1}{2}$ hours : —

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3361 gram.	83.2 per cent.	100.0
5 " absol. alcoh.	0.4040 "	79.8 "	95.9
10 " brandy	0.4242 "	78.8 "	94.7
10 " " distil.	0.4286 "	78.6 "	94.4
10 " " residue in alcohol	0.4334 "	78.4 "	94.2
10 " " residue in water	0.3609 "	82.0 "	98.5

[1] Dissolved in water, being the residue from this percentage of brandy.

Experiment 43.

In this experiment four distinct samples of brandy were used.

Conditions:

Proteid = blood-fibrin (2 grams).

0.009 gram pepsin; 0.2 per cent. hydrochloric acid.

Period of digestion $1\frac{1}{12}$ hours at 38°–40° C.

Brandy.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.7941 gram.	60.3 per cent.	100.0
10 "	1.0007 "	50.0 "	82.9
10 "	0.9357 "	53.3 "	88.3
10 "	0.9304 "	53.5 "	88.7
10 "	0.9014 "	55.0 "	91.2

The experiments here recorded indicate that brandy has a slight retarding action on pepsin-proteolysis when present in quantities ranging from five to ten per cent. When the gastric juice is relatively weak, then the retardation may be quite pronounced, as in Experiment 38. Such action as the brandy possesses is due almost wholly to the contained alcohol. Indeed, the solid matter present in brandy when separated and dissolved in water may even cause a slight increase in the rate of proteolysis. Evidently, we may draw the same conclusions regarding brandy that have been drawn in connection with whiskey. Both owe their action mainly to the contained alcohol; the results obtained with ten per cent. of brandy being essentially the same as those obtained with five per cent. of absolute alcohol under like conditions.

Rum.

The only essential difference between whiskey and rum, as generally understood, is in the character of the aroma or flavor, and, as the volatile products which are the cause of the flavor are present only in very small quantity, it might be assumed that these two liquors would be very much alike in their general physiological action. The sample of rum (St. Croix rum, at $1.25 per quart) with which our experiments were mainly made had the following composition: —

Specific gravity	0.935 (at 18.5° C.).
Alcohol by volume	50.8–51.0 per cent.
Solid residue at 110° C.	0.3068 gram per 100 c. c.
Ash	0.0070 " " "
Reaction acid.	

Experiment 44.

Conditions :

Proteid = blood-fibrin (2 grams).

0.016 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion $2\frac{1}{4}$ hours at 38°–40° C.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2013 gram.	90.0 per cent.	100.0
5 " rum	0.2304 "	88.5 "	98.3
5 " whiskey	0.2312 "	88.5 "	98.3
5 " absol. alcoh.	0.2601 "	87.0 "	96.6

Experiment 45.

Conditions the same as in the preceding experiment, except that the period of digestion was $1\frac{5}{6}$ hours: —

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3995 gram.	80.1 per cent.	100.0
5 " absol. alcoh.	0.5392 "	73.1 "	91.2
10 " rum	0.5029 "	74.9 "	93.5
10 " " distillate	0.4561 "	77.2 "	96.3
10 " " residue in 50 pr. ct. alcoh.	0.4691 "	76.6 "	95.6
10 " rum residue in water	0.4290 "	78.6 "	98.1

Experiment 46.

Conditions the same as in the preceding experiment, except that the period of digestion was $2\frac{1}{4}$ hours: —

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1759 gram.	91.3 per cent.	100.0
5 " rum residue [1]	0.1589 "	92.1 "	100.8
5 " whiskey residue [2]	0.1847 "	90.8 "	99.4
5 " absolute alcohol	0.2145 "	89.3 "	97.8

The results plainly indicate that rum is essentially similar to whiskey in its action on artificial gastric digestion, and that such retardation as it causes is due mainly to the contained alcohol.

Gin.

Our experiments with this liquor were conducted solely with a sample of so-called "pure Holland gin," the composition of which was as follows: —

[1] Residue dissolved in water. [2] Ibid.

Specific gravity	0.937 (at 16° C.).
Alcohol by volume	51.0 per cent.
Solid residue at 110° C.	0.2968 gram per 100 c. c.
Ash	0.0090 " " "

Reaction very slightly acid.

Experiment 47.

Conditions:

Proteid = blood-fibrin (2 grams).
0.015 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $1\frac{5}{6}$ hours at 38°–40° C.

Gin.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4210 gram.	79.0 per cent.	100.0
1 "	0.4722 "	76.4 "	96.7
3 "	0.4681 "	76.6 "	96.9
5 "	0.4938 "	75.4 "	95.4
10 "	0.5725 "	71.4 "	90.3
Absolute alcohol.			
5 per cent.	0.5506 "	72.5 "	91.7

Experiment 48.

Conditions:

Proteid = blood-fibrin (2 grams).
0.008 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $1\frac{2}{3}$ hours at 38°–40° C.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.9045 gram	54.8 per cent.	100.0
10 " gin	1.0230 "	48.9 "	89.2
10 " distillate	0.9961 "	50.2 "	91.4
10 " residue [1]	0.9508 "	52.5 "	75.8
5 " absol. alcoh.	1.0104 "	49.5 "	90.3

The results plainly indicate an action on pepsin-proteolysis exactly analogous to that of the related fluids, — whiskey, rum, and brandy. As in the case of the latter, such action as the gin possesses is to be ascribed solely to the contained alcohol: the action of ten per cent. of gin, with its fifty per cent. of alcohol, being practically identical with that of five per cent. of absolute alcohol or ten per cent. of proof spirit.

Action of Wines.

In considering the action of wines on gastric digestion it is to be remembered that we have to deal with a class of beverages which naturally contain far less alcohol than the liquors already

[1] Dissolved in water.

discussed. The prominence which they have as accessories to food, however, and the relatively larger quantities in which they are consumed lend special importance from a physiological standpoint to a study of their action. Further, the greater complexity of wines in chemical composition naturally introduces a variety of factors, aside from the alcohol, which necessarily merit some consideration. It is likewise to be remembered that while wines are supposed to consist simply of pure grape-juice fermented and clarified, there is a large manufacture of artificial wines, both in Europe and in this country, in which "raisins, cider, sugar, alcohol, glycerin, tartaric acid, cream of tartar, coloring matter, wine-flavors, and water" are the principal substances used.[1]

With special reference to the content of alcohol we may divide wines into the two classes of heavy and light, — i. e., those which contain a comparatively large percentage of alcohol, as sherry and port, and those which contain a smaller amount of alcohol, such as clarets and hocks. With reference to the many grades of California wines which are being so widely used at present in this country, we may refer to a recent report on their chemical composition and characteristics by Dr. King.[2]

Sherry.

Our experiments were commenced with a brand of sherry sold as "Amontillado Sherry," at 75 cents per quart. Its composition was found to be as follows: —

Specific gravity	0.997 (at 17.5° C.).
Alcohol by volume	20.75–21.75 per cent.
Solid residue at 110° C.	4.7338 grams per 100 c. c.
Ash	0.4154 gram " "
Reaction acid.	

Experiment 49.

Conditions :

Proteid = cooked beef proteids[3] (10 grams).

10 grams beef contain 4.3262 grams dry proteid.

[1] See report by Dr. Englehardt in the *Second Annual Report of the State Board of Health of New York*, p. 619.

[2] "Some Characteristics of California Wines," by W. H. King, of the Chemical Laboratory of the U. S. Department of Agriculture. *Journal of Amer. Chem. Soc.*, vol. xvi. p. 597.

[3] Washed free from all soluble matters and freed from fat.

0.016 gram pepsin ; 0.2 per cent. hydrochloric acid.
Period of digestion $7\frac{1}{6}$ hours at 38°–40° C.

Sherry.	Undigested beef.	Proteid digested.	Relative proteolytic action.
0 per cent.	1.9810 grams.	54.3 per cent.	100.0
1 "	2.0839 "	51.9 "	95.5
3 "	2.0995 "	51.5 "	94.8
6 "	2.1102 "	51.3 "	94.4

Experiment 50.

Conditions :

Proteid = blood-fibrin (2 grams).
0.016 gram pepsin ; 0.2 per cent. hydrochloric acid.
Period of digestion $2\frac{3}{4}$ hours at 38°–40° C.

Sherry.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3646 gram.	81.8 per cent.	100.0
1 "	0.3555 "	82.3 "	100.6
3 "	0.4075 "	79.7 "	97.4
6 "	0.4213 "	79.0 "	96.5

Experiment 51.

Conditions :

Proteid = fluid egg-albumin (15 c. c.).
15 c. c. albumin solution contain 1.0522 grams dry albumin.
0.0024 gram pepsin ; 0.2 per cent. hydrochloric acid.
Period of digestion $5\frac{3}{4}$ hours at 38°–40° C.

Sherry.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4547 gram.	56.8 per cent.	100.0
1 "	0.5072 "	51.8 "	91.1
3 "	0.5101 "	51.6 "	90.8
5 "	0.5806 "	44.9 "	79.0
7 "	0.5916 "	43.8 "	77.1
Sherry residue.[1]			
1 per cent.	0.4912 "	53.4 "	94.
7 "	0.5482 "	47.9 "	84.3

Experiment 52.

Conditions :

Proteid = fluid egg-albumin (15 c. c.).
15 c. c. albumin solution contain 1.1948 grams dry albumin.
0.0024 gram pepsin ; 0.2 per cent. hydrochloric acid.
Period of digestion $5\frac{7}{12}$ hours at 38°–40° C.

[1] The residue left on evaporation of the sherry. This was then dissolved in water and introduced into the digestive mixtures, the percentages referred to being the amount of residue contained in one per cent. and seven per cent. of the original sherry, respectively.

Sherry.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.6503 gram.	45.6 per cent.	100.0
1 "	0.6578 "	45.0 "	98.6
3 "	0.6930 "	42.0 "	92.1
6 "	0.7533 "	37.0 "	81.1
Sherry residue.			
1 per cent.	0.6728 "	43.7 "	95.8
6 "	0.6560 "	45.1 "	98.9

Experiment 53.

The conditions were the same as in the preceding experiment, excepting that the period of digestion was $6\frac{5}{12}$ hours : —

Sherry.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.6617 gram.	44.7 per cent.	100.0
1 "	0.6864 "	42.6 "	95.3
3 "	0.7304 "	38.9 "	87.0
6 "	0.7368 "	38.4 "	85.9
Sherry residue.			
1 per cent.	0.6839 "	42.8 "	95.7
3 "	0.6810 "	43.1 "	96.4
6 "	0.6314 "	47.2 "	105.5

Experiment 54.

Conditions :

Proteid = blood-fibrin (2 grams).
0.016 gram pepsin ; 0.2 per cent. hydrochloric acid.
Period of digestion $2\frac{1}{4}$ hours at 38°–40° C.

Fluid added.	Undigested fibrin	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2013 gram.	90.0 per cent.	100.0
5 " absol. alcoh.	0.2601 "	87.0 "	96.6
5 " sherry	0.3401 "	84.8 "	94.2

From these results it is plain that while sherry wine has a marked retarding effect on gastric digestion — an effect which increases with the weakness of the gastric juice — the inhibitory action is out of all proportion to the amount of contained alcohol. Thus, ten per cent. of the sherry used in these experiments would be equivalent simply to two per cent. of absolute alcohol, an amount which, as we have seen, is wholly inadequate to bring about the retardation in proteolysis observed with sherry. Indeed, two per cent. of alcohol is more liable to be without any marked influence on pepsin-proteolysis. The presence of five per cent. of sherry, however, as our last experiment shows, has a far greater retarding effect than even five

per cent. of absolute alcohol. It is thus evident that we must look elsewhere for an explanation of the action of sherry wine on gastric digestion. Buchner,[1] in his investigations of the influence of alcoholic liquors on peptic digestion, found that the light white and red French wines retarded digestion far more than corresponding quantities of alcohol. Similar results were obtained with the stronger Hungarian wines (Ruster and Tokayer). Especially unfavorable was the action of Marsala wine. Buchner attributed these results to the presence of the "*bouquet stoffe*." It is evident, however, from our results that with sherry regard must be had to the residue or solid matter contained in the wine. This, as our analysis shows, is present in the wine to the extent of approximately 4.75 per cent., the greater proportion of which is organic matter. Further, it is evident that this solid matter, when free from the alcohol of the wine, has by itself a distinct influence on peptic digestion. So far as our experiments show, small amounts of this solid matter retard peptic digestion more than larger quantities. Indeed, in one case the solid matter equivalent to six per cent. of sherry increased the digestive action of the artificial gastric juice quite appreciably. Evidently there are various factors of unknown nature in this residue which exert an influence, not always constant, upon the rate of digestive proteolysis by pepsin-hydrochloric acid.

The following experiments throw some additional light upon this subject: —

Experiment 55.

Conditions:

Proteid = blood-fibrin (2 grams).

0.016 gram pepsin; 0.2 per cent. hydrochloric acid.

Period of digestion $2\frac{1}{4}$ hours at 38°–40° C.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2027 gram.	89.9 per cent.	100.0
5 " sherry	0.2340 "	88.3 "	98.2
5 " " residue	0.2627 "	86.9 "	96.6
5 " absol. alcoh.	0.2619 "	87.0 "	96.7

Experiment 56.

Conditions the same as in the preceding experiment, except that the mixtures were warmed at 38°–40° C. for $1\frac{7}{12}$ hours.

[1] *Deutsches Archiv f. klin. Med.*, xxix. 537.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3247 gram.	83.8 per cent.	100.0
5 " absol. alcoh.	0.3554 "	82.3 "	98.2
10 " sherry	0.4785 "	76.1 "	90.8
10 " " distillate [1]	0.2855 "	85.8 "	102.3
10 " " residue	0.4153 "	77.8 "	92.8

It is thus evident that so far as the alcohol and other volatile substances present in sherry are concerned, the amount introduced into an artificial gastric juice with ten per cent. of sherry (i. e., 10 c. c.) tends to increase quite distinctly the rate of digestion. Hence, the substance or substances which give the bouquet to this wine are probably not the cause of the retardation in digestive action, but this is to be traced directly and solely to the substance or substances which make up the solid matter of the wine. Obviously, however, if sherry be mixed with gastric juice in such quantity as to introduce five, ten, or fifteen per cent. of absolute alcohol the latter will produce its ordinary retardation of proteolytic action, although doubtless lessened somewhat by the bouquet or other volatile material which apparently stimulates rather than retards peptic digestion.

Our results are thus more or less in accord with the results obtained by Sir William Roberts,[2] who in writing of the effects of sherry and port on gastric digestion says, "It is evident that the retarding effects of sherry and port considerably exceed what is due to the alcohol contained in them. The table shows that when the digesting mixture contained forty per cent. of either wine the action of the ferment was brought almost to a standstill. These wines are estimated to contain about twenty per cent. of absolute alcohol (or forty per cent. of proof spirit); therefore, forty per cent. of these wines is only equivalent in alcoholic strength to sixteen per cent. of proof spirit — and this proportion of alcohol retards digestion only slightly. Even in the proportion of twenty per cent., sherry trebled the time in which digestion was completed. There must, therefore, be in these wines some retarding agent besides alcohol."

We may quote Dr. Roberts still further in this connection,

[1] Being the distillate from this amount of sherry and containing obviously all of the alcohol together with the other volatile substances present therein.

[2] *Digestion and Diet:* "Effect of Food Accessories on Peptic Digestion," London, 1891, p. 134.

since his statements express so clearly our own conclusions based upon the results we have obtained: "As used dietetically, sherry must figure as having frequently an important retarding effect on peptic digestion. This wine is used with dinner by some persons very freely. Half a pint of sherry is no unusual allowance, and this in a total gastric charge of two pounds amounts to about twenty-five per cent., which the table shows to be a highly inhibitory proportion. In the more common practice of taking two or three wineglasses of sherry with dinner, we see probably a double action — a stimulating action on the secretion of gastric juice and on the muscular contractions of the stomach, and a slight retarding effect on the speed of the chemical process, especially in its early stages. In smaller proportions — a wineglass or so — sherry would act as a pure stimulant to digestion." On the purely chemical process of gastric digestion, however, we should be inclined, from the results of our own experiments, to insist that even small amounts of sherry may exert a slight inhibitory action. As to the cause of the retarding action of sherry, Roberts considers it due largely to the volatile constituents of the wine other than the alcohol, while our experiments would lead us to believe that it is attributable mainly to the character of the solid matter contained therein.

Claret.

Our experiments with claret were conducted solely with a California wine of ordinary grade, known as "Chateau Roland, Bordeaux," sold at thirty cents a quart. Its composition was as follows: —

Specific gravity	1.000 (at 20° C.).
Alcohol by volume	9.75–10.0 per cent.
Solid residue at 110° C.	3.3056 grams per 100 c. c.
Ash	0.6336 gram " "
Reaction strongly acid.	

That this was a typical sample of a California wine of the claret type, at least so far as the content of alcohol is concerned, is indicated by the fact that King[1] states in his paper on the "Characteristics of California Wines" that California clarets contain 9.16–11.23 per cent. of alcohol.

[1] *Loc. cit.*

Experiment 57.

Conditions:

Proteid = blood-fibrin (2 grams).
0.016 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $2\frac{5}{12}$ hours at 38°–40° C.

Claret.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3401 gram.	83.0 per cent.	100.0
1 "	0.3252 "	83.8 "	100.9
3 "	0.3965 "	80.2 "	96.6
6 "	0.3732 "	81.4 "	98.0

Experiment 58.

Conditions:

Proteid = fluid egg-albumin (15 c. c.).
15 c. c. albumin solution contain 1.347 grams dry albumin.
0.04 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 7 hours at 38°–40° C.

Claret.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5800 gram.	57.0 per cent.	100.0
1 "	0.5313 "	60.6 "	106.3
3 "	0.5899 "	56.3 "	98.7
6 "	0.5892 "	56.3 "	98.7
Claret residue.[1]			
1 per cent.	0.5865 "	56.5 "	99.1
3 "	0.5253 "	61.0 "	107.2
6 "	0.5903 "	56.2 "	98.5

Experiment 59.

Conditions:

Proteid = fluid egg-albumin (15 c. c.).
15 c. c. albumin solution contain 1.1948 grams dry albumin.
0.0024 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $5\frac{1}{12}$ hours at 38°–40° C.

Claret.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.6808 gram.	43.2 per cent.	100.0
1 "	0.6801 "	43.2 "	100.0
3 "	0.6950 "	41.9 "	96.9
5 "	0.7258 "	39.3 "	90.9
7 "	0.7238 "	39.5 "	91.2
Claret residue.			
1 per cent.	0.6546 "	45.3 "	104.8
3 "	0.6785 "	43.3 "	100.5
7 "	0.6847 "	42.7 "	98.8

[1] The residue left on evaporation of the claret. The several percentages refer to the original claret, i. e., the one per cent. claret residue being the residue from one per cent. of claret.

Experiment 60.

Conditions :

Proteid = fluid egg-albumin (15 c. c.).

15 c. c. albumin solution contain 1.347 grams dry albumin.

0.0024 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion $6\frac{1}{4}$ hours at 38°–40° C.

Claret.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.7659 gram.	43.2 per cent.	100.0
1 "	0.7839 "	41.9 "	96.9
3 "	0.7980 "	40.8 "	94.4
6 "	0.8161 "	39.5 "	91.2
Claret residue.			
1 per cent.	0.7589 "	43. "	101.1
6 "	0.7644 "	43.2 "	100.0

Experiment 61.

Conditions :

Proteid = blood-fibrin (2 grams).

0.016 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion $2\frac{1}{4}$ hours at 38°–40° C.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2013 gram.	90.0 per cent.	100.0
5 " absol. alcoh.	0.2601 "	87.0 "	96.6
5 " claret	0.2560 "	87.2 "	96.8

Experiment 62.

Conditions exactly the same as in the preceding experiment.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1759 gram.	91.3 per cent.	100.0
5 " absol. alcoh.	0.2145 "	89.3 "	97.8
5 " claret residue	0.2214 "	89.0 "	97.4

From a careful scrutiny of these results several conclusions are obvious : First, the presence of small amounts of claret, say one per cent., in a digestive mixture tends to increase rather than to decrease digestive action. Large amounts of claret have a distinct inhibitory action on pepsin-proteolysis, which, however, is not anywhere near so pronounced as with sherry. To be sure, the content of alcohol in the claret is only half that of the sherry, but even six per cent. of claret is equal to only 0.6 per cent. of absolute alcohol. Yet the retardation produced by the presence of five per cent. of claret is about equivalent to that caused by five per cent. of absolute alcohol. Consequently,

the retardation in gastric digestion witnessed in the presence of the above percentages of claret is hardly to be attributed to the contained alcohol.

With the solid matter present in claret our results are not strictly concordant; thus, some of our experiments tend to show that the solid matter present in this wine has a direct stimulating effect, while in other experiments the retardation produced by the solid matter of the wine is exactly equal to that of the wine itself. We have not been able to come to any satisfactory conclusion on this point, the only plausible suggestion that we have to offer being that possibly the difficulty lies in the variable character of the coloring and other matters present in the wine. In any event, the alcohol present in this wine is answerable for its action on gastric digestion only to a very limited extent. Again, we find our results in close accord with those obtained by Roberts. Thus, this investigator states that the effect of both claret and hock is out of all proportion to the alcohol contained in them: "These wines are estimated to contain from ten to twenty per cent. of absolute alcohol, so that, however freely they might be used dietetically, the amount of alcohol so introduced, even if they were used up to eighty per cent. of the total contents of the stomach, would scarcely produce an appreciable effect on peptic action. We must, therefore, again here recognize the presence of some other retarding agent besides alcohol.

"If we consider the copious proportions in which hock and claret are used dietetically, it becomes evident that their retarding effect on peptic digestion is often brought into play. A pint of claret or hock is a common allowance with dinner for robust eaters — and such a proportion as the table shows would not be without considerable effect. . . . On the other hand, the more sparing use of these wines, a glass or two, with dinner or luncheon would evidently not produce any appreciable retardation of peptic action, but would, like corresponding doses of sherry, act as pure stimulants. In both these instances, as in some others, it seems to be indicated that by adjusting the quantities we may elicit diverse effects. With large quantities we may obtain retardation, with small quantities we may obtain acceleration, of gastric digestion."[1] With these statements our results are mainly in accord.

[1] Roberts, *Digestion and Diet*, p. 136.

White Wine of the Rhenish Type.

In our study of this kind of wine we employed a California wine sold under the name of "Hochheimer" at thirty-five cents per quart. Our analysis of the brand employed gave the following results: —

Specific gravity	0.997 (at 17° C.).
Alcohol by volume	11.0 per cent.
Solid residue at 110° C. . . .	1.8436 grams per 100 c. c.
Ash	0.2236 gram " "
Reaction acid.	

The wines of this type, as King states, are characterized by a content of alcohol varying from 8.45 to 11.67 per cent., and with an acidity equal to 0.50 to 0.65 per cent. of tartaric acid.

Experiment 63.

Conditions:

Proteid = blood-fibrin (2 grams).

0.016 gram pepsin; 0.2 per cent. hydrochloric acid.

Period of digestion $1\frac{1}{6}$ hours at 38°–40° C.

White wine.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2829 gram.	85.9 per cent.	100.0
1 "	0.2716 "	86.5 "	100.6
3 "	0.3122 "	84.4 "	98.2
6 "	0.3464 "	82.7 "	96.2

Experiment 64.

Conditions same as above, but the period of digestion $2\frac{1}{4}$ hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2013 gram.	90.0 per cent.	100.0
5 " wine	0.2439 "	87.9 "	97.6
5 " absol. alcoh.	0.2601 "	87.0 "	96.6

Experiment 65.

Conditions the same as in the preceding experiment.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1759 gram.	91.3 per cent.	100.0
5 " absol. alcoh.	0.2145 "	89.3 "	97.8
5 " wine residue	0.2158 "	89.3 "	97.8

Experiment 66.

Conditions same as above, but the period of digestion $1\frac{1}{4}$ hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2032 gram.	89.9 per cent.	100.0
5 " absol. alcoh.	0.2317 "	88.5 "	98.4
10 " wine	0.2531 "	87.4 "	97.2
10 " " distillate[1]	0.2063 "	89.7 "	99.7
10 " " residue	0.2810 "	86.0 "	95.6

From these results it is obvious that essentially the same conclusions can be drawn with regard to this white wine as have been applied to claret. A small quantity, such as one per cent., has no retarding action on pepsin-proteolysis, but tends rather to increase the rate of digestion. Larger amounts of the wine, say ten per cent., have a small retarding effect, which is due almost wholly to the solid matter present in the wine rather than to the alcohol or other volatile matter. Thus, the distillate (Experiment 66) corresponding to ten per cent. of the original wine had almost no retarding action on gastric digestion, while the residue from the same amount of wine caused a retardation even greater than that produced by the wine itself. At the same time, it is to be noticed that the white wine is far less active in retarding pepsin-proteolysis than the red wine. This difference in intensity of action depends probably upon the character of the solid matter present in the wine, or possibly upon the amount of such matter; the claret containing 3.3056 grams of solid matter per 100 c. c., while the white wine contained only 1.8436 grams per 100 c. c. Doubtless, however, differences in the methods of treating the grape in the manufacture of the wine, the processes of plastering and mixing, as well as the variations the artistic mixer of wines may introduce, all have an influence in determining the character of this solid residue, which seems far more potent than the alcohol in acting upon the digestive process.

Hence, we may conclude that wines as a class, taken in small amount, have little or no deleterious influence upon the chemical processes of gastric digestion. In small amounts they may even increase somewhat the rate of digestive action owing to

[1] Being the volatile matter, alcohol, etc., obtainable from an amount of wine equivalent to ten per cent. of the original hochheimer.

the alcohol, and perhaps other substances, contained in them. In larger quantities they have more or less of a retarding effect upon gastric digestion; an effect which is dependent rather upon the character and the amount of solid matter present in the fluid than upon the contained alcohol, bouquet-flavoring, or other volatile material. Indeed, wines differ most markedly from liquors of the brandy and whiskey type, in that their action upon gastric digestion is not at all proportional to their content of alcohol. As we have seen, whiskeys, brandies, etc., owe their action upon pepsin-proteolysis almost wholly to the contained alcohol, while in wines, say with ten per cent. of alcohol, the alcohol is of minor importance so far as the influence of the fluid upon the solvent or digestive power of the gastric juice is concerned.

Direct Comparison of the Action of Some of the Foregoing Liquors.

The comparative action of the alcoholic fluids thus far studied has perhaps been made sufficiently clear, but inasmuch as the conditions under which proteolysis occurs have such an important bearing upon the rate of digestion, we have deemed it wise to make an experiment with representatives of the different liquors in which all of the attendant conditions should be identical. The results are shown in the following experiment: —

Experiment 67.

Conditions:

Proteid = blood-fibrin (2 grams).
0.016 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $2\frac{1}{4}$ hours at 38°–40° C.

Fluid used, five per cent.	Alcoholic strength.[1]	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0	0	0.2013 gram.	90.0 per cent.	100.0
Absol. alcoh.	99.5 per cent.	0.2601 "	87.0 "	96.6
Rum	51.0 "	0.2304 "	88.5 "	98.3
Whiskey	50.5 "	0.2312 "	88.5 "	98.3
Brandy	47.5 "	0.2251 "	88.8 "	98.7
Sherry	21.0 "	0.3041 "	84.8 "	94.2
Hochheimer	11.0 "	0.2439 "	87.9 "	97.6
Claret	10.0 "	0.2560 "	87.2 "	96.8

These results, obtained under exactly similar conditions, are suggestive in that they show so clearly the relative retarding

[1] Being the content of alcohol in the fluid added.

action of these several alcoholic fluids. Sherry, with its high content of solid matter (about 4.75 per cent.), shows the greatest retarding action, while claret and absolute alcohol come next, followed by the hochheimer. Rum, whiskey, and brandy, with the highest content of alcohol, produce the least effect, in harmony with the preceding experiments, so that we again have evidence of the greater retarding effect of the solid matters contained in wines. Alcohol plainly reduces the rate of pepsin-proteolysis, but five per cent. of pure absolute alcohol has no greater retarding action than the same percentage of claret with only one tenth as much absolute alcohol. Again, rum, whiskey, and brandy cause approximately only half the retardation that the same percentage of claret will produce, although the latter contains only one fifth as much absolute alcohol.

Action of Malt Liquors.

Under this term are included a large variety of beverages, such as beers, ales, porter, stout, etc., all of which are supposed to contain only a comparatively small amount of alcohol, with a relatively large amount of extractive matter. "The composition of malt liquors varies greatly according to the materials used, the method of brewing, the season, and the use for which it is intended. . . . The chemical composition is very complex, the principal constituents being alcohol, various sugars, and carbohydrates, nitrogenous matter, carbonic, acetic, succinic, lactic, malic, and tannic acids, bitter and resinous extractive materials from the hops, glycerin, and various mineral constituents, consisting mainly of phosphates of the alkalies and alkali earths."[1]

The following table shows the maximum and minimum content of alcohol, extract, and ash in 476 samples obtained in American markets:[2]—

[1] *Bulletin* 13, part 3, p. 275, U. S. Department of Agriculture, Division of Chemistry.

[2] *Ibid.*, p. 279.

Kind.	Maximum.			Minimum.		
	Alcohol by weight.	Extract.	Ash.	Alcohol by weight.	Extract.	Ash.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Lager .	7.061	9.647	0.412	0.677	3.655	0.172
Ale . .	8.994	9.501	0.552	2.410	2.703	0.197
Porter .	6.695	11.783	0.557	1.671	2.843	0.170
Weiss .	3.179	4.143	0.486	0.755	1.277	0.069

A recent examination[1] of Munich beer made in the analytical laboratory of the London "Lancet," with which the composition of English beer has been contrasted, gave the following results: —

	Munich beer. Löwenbräu.	English beers. Mild.	English beers. Bitter.
Alcohol by weight	3.55 per cent.	6.78 per cent.	5.44 per cent.
Alcohol by volume	4.45 "	8.45 "	6.78 "
Equal to proof spirit	7.80 "	14.81 "	11.89 "
Total malt extractives	7.09 "	6.74 "	5.42 "
Mineral matters	0.36 "	0.43 "	0.24 "
Albuminous matters	0.57 "	0.26 "	0.16 "
Maltose and dextrin	6.15 "	5.77 "	4.22 "

Toledo Lager Beer.

A partial analysis of this beer gave us the following results: —

Specific gravity	1.019 (at 17.5° C.).
Alcohol by volume	2.75 per cent.
Extract	5.9856 grams per 100. c. c.
Ash	0.1820 gram " "

Experiment 68.

Conditions:

Proteid = fluid egg-albumin (15 c. c.).
15 c. c. of the albumin solution contain 1.3395 grams dry albumin.
0.006 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 7 hours at 38°–40° C.

[1] London *Lancet*, February 16, 1895.

Beer.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4121 gram.	69.3 per cent.	100.0
1 "	0.4110 "	69.4 "	100.1
3 "	0.4347 "	67.6 "	97.5
5 "	0.4314 "	67.8 "	97.8
7 "	0.5183 "	61.4 "	88.6
Beer residue.			
1 per cent.	0.4042 "	69.9 "	100.9
7 "	0.4546 "	66.1 "	95.3

Milwaukee Bock Beer.

This sample of beer, " Milwaukee Lager Beer, Pabst's Bock," had the following composition : —

Specific gravity	1.017 (at 17.5° C.).
Alcohol by volume	2.5 per cent.
Extract	2.6479 grams per 100 c. c.
Ash	0.1462 gram " "

Experiment 69.

Conditions :

Proteid = blood-fibrin (2 grams).

0.016 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion $1\frac{1}{6}$ hours at 38°–40° C.

Beer.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2829 gram.	85.9 per cent.	100.0
1 "	0.2738 "	86.4 "	100.5
3 "	0.3085 "	84.6 "	98.4
6 "	0.3183 "	84.1 "	97.9
Beer residue.			
6 per cent.	0.3079 "	84.6 "	98.4

New Haven Lager Beer.

This beer gave on analysis the following results : —

Specific gravity	1.026 (at 18° C.).
Alcohol by volume	1.5 per cent.
Extract	7.1236 grams per 100 c. c.
Ash	0.2192 gram " "

Experiment 70.

Conditions :

Proteid = cooked and washed beef proteid (10 grams moist).

10 grams beef proteid contain 4.3262 grams dry proteid.

0.016 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion $7\frac{1}{6}$ hours at 38°–40° C.

Beer.	Undigested proteid.	Proteid digested.	Relative proteolytic action.
0 per cent.	1.9810 grams.	54.3 per cent.	100.0
1 "	1.9513 "	54.9 "	101.1
3 "	2.0189 "	53.4 "	98.3

Experiment 71.

Conditions :

Proteid = blood-fibrin (2 grams).

0.016 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion $2\frac{3}{4}$ hours at 38°–40° C.

Beer.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3646 gram.	81.8 per cent.	100.0
3 "	0.3591 "	82.1 "	100.3
6 "	0.3961 "	80.2 "	98.0

Experiment 72.

Conditions the same as in the preceding experiment, except that the period of digestion was $2\frac{1}{12}$ hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4630 gram.	76.9 per cent.	100.0
2 " absol. alcoh.	0.4583 "	77.1 "	100.2
10 " beer	0.5218 "	74.0 "	96.2
10 " " residue	0.5134 "	74.4 "	96.7
10 " " distillate	0.4127 "	79.4 "	103.2

From these experiments with beer containing a low content of alcohol, it is seen that the tendency is toward a slight retardation of proteolysis. The extent of retardation with a given percentage of beer is dependent, however, upon the digestive strength of the gastric juice. Where digestive action is fairly strong, retardation with, say, ten per cent. of beer is very slight, and if we are to trust the result of Experiment 72 the inhibitory action is to be connected mainly with the extractive matters present in the beer rather than with the alcohol. Indeed, the amount of alcohol in these beers is altogether too small to have any appreciable retarding action upon the chemical processes of gastric digestion unless the beverage is consumed in very large quantity.

Especially noticeable is the constant, though slight, stimulation of proteolysis caused by a small percentage of beer.

According to Roberts, beer, when "well up," is distinctly more favorable to quick digestion than the same beer when

"flat." This effect, he adds, is probably due to the mechanical effect of the escaping gas in stirring up the mixture.

Ale.

The ale used in the following experiments was "Burton Pale Ale," Bass & Co.'s Extra. A partial analysis of one sample gave the following results: —

Specific gravity	1.014 (at 20° C.).
Alcohol by volume	4.0 per cent.
Extract	4.4254 grams per 100 c. c.
Ash	0.3530 gram " "

In another sample the content of alcohol was 5.25 per cent.

Experiment 73.

Conditions :

Proteid = fluid egg-albumin (15 c. c.).

15 c. c. albumin solution contain 1.347 grams dry albumin.

0.0024 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion $6\frac{5}{12}$ hours at 38°–40° C.

Ale.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.7861 gram.	41.7 per cent.	100.0
1 "	0.7908 "	41.3 "	99.0
3 "	0.7826 "	41.9 "	100.3
5 "	0.8304 "	38.4 "	92.0
7 "	0.8496 "	37.0 "	88.7
Ale residue.			
1 per cent.	0.7498 "	44.0 "	105.5
7 "	0.8094 "	40.0 "	95.9

Experiment 74.

Conditions :

Proteid = blood-fibrin (2 grams).

0.016 gram pepsin ; 0.2 per cent. hydrochloric acid.

Period of digestion $2\frac{1}{2}$ hours at 38°–40° C.

Ale.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4263 gram.	78.7 per cent.	100.0
1 "	0.4528 "	77.4 "	98.3
3 "	0.4636 "	76.9 "	97.7
6 "	0.5031 "	74.9 "	95.1

Experiment 75.

Conditions the same as in the preceding experiment, except that the period of digestion was $1\frac{3}{4}$ hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5068 gram.	74.7 per cent.	100.0
2 " absol. alcoh.	0.4970 "	75.2 "	100.6
10 " ale	0.7218 "	64.0 "	85.6
10 " " distillate	0.5302 "	73.5 "	98.3
10 " " residue [1]	0.6988 "	65.1 "	87.1
10 " " " [2]	0.7060 "	64.7 "	86.6

The results are essentially of the same order as those obtained with beer, although the ale appears to have a somewhat greater retarding action than lager beer.

Porter.

The porter used in our experiments was labeled "Feigenspan's," Newark, and had the following composition: —

Specific gravity	1.011 (at 18.5° C.).
Alcohol by volume	3.75 per cent.
Extract	4.4470 grams per 100 c. c.
Ash	0.2586 gram " "

Experiment 76.

Conditions:

Proteid = blood-fibrin (2 grams).
0.016 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $2\frac{5}{12}$ hours at 38°–40° C.

Porter.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3401 gram.	83.0 per cent.	100.0
1 "	0.4038 "	79.9 "	96.2
3 "	0.4226 "	78.9 "	95.0
6 "	0.4335 "	78.4 "	94.4

Experiment 77.

Conditions the same as in the preceding experiment, except that the period of digestion was $2\frac{1}{4}$ hours: —

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3881 gram.	80.6 per cent.	100.0
4 " absol. alcoh.	0.4118 "	79.5 "	98.6
10 " porter	0.4208 "	79.0 "	98.0
10 " " distillate	0.3783 "	81.1 "	100.6
10 " " residue [1]	0.4480 "	77.6 "	96.2
10 " " " [2]	0.4417 "	77.8 "	96.5

[1] Made up to contain four per cent. of alcohol.
[2] Dissolved in water.

Porter is thus seen to have about the same retarding action on pepsin-proteolysis as lager beer, although not showing the stimulation so characteristic of small quantities of this latter fluid. Further, such retardation as is produced is associated mainly with the presence of the extractives rather than with the volatile matters present in the fluid.

Stout.

The stout used was "Guiness's Dublin Stout," with the following composition: —

Specific gravity	1.013.
Alcohol by volume	5.5 per cent.
Extract	5.4220 grams per 100 c. c.
Ash	0.3612 gram " "

Experiment 78.

Conditions:

Proteid = blood-fibrin (2 grams).

0.016 gram pepsin; 0.2 per cent. hydrochloric acid.

Period of digestion $2\frac{1}{2}$ hours at 38°–40° C.

Stout.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4263 gram.	78.7 per cent.	100.0
1 "	0.4133 "	79.4 "	100.8
3 "	0.4440 "	77.8 "	98.8
6 "	0.4839 "	75.9 "	96.4

Experiment 79.

Conditions the same as in the preceding experiment, except that the period of digestion was two hours: —

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5315 gram.	73.5 per cent.	100.0
2 " absol. alcoh.	0.5390 "	73.1 "	99.4
10 " stout	0.6582 "	67.1 "	91.2
10 " " distillate	0.5317 "	73.5 "	100.0
10 " " residue [1]	0.6665 "	66.7 "	90.7
10 " " " [2]	0.6675 "	66.7 "	90.7

Here, again, we have essentially the same results as were obtained with lager beer and ale. With ten per cent. of stout there is a distinct retardation of pepsin-proteolysis, perhaps

[1] Made up to contain four per cent. of alcohol.

[2] Dissolved in water.

even greater than with either of the other fluids of this class; a retardation, however, that is due almost wholly to the contained extractives rather than to the alcohol or other volatile matters. Thus, while the distillate from this liquor is entirely without action upon pepsin-proteolysis, the residue or extractive matter inhibits digestion to about the same extent as the beverage itself.

Taken collectively, our experiments with malt liquors tend to show that the retarding effect of these fluids is, as is the case with wines, altogether out of proportion to their content of alcohol. Containing, as a rule, not much more than from four to six per cent. of alcohol, the latter, when consumed in the ordinary forms of malt liquors, can have very little influence upon the chemical processes of gastric digestion. When, however, these beverages are consumed very freely with the meals, so that the digesting mass in the stomach contains fifty or sixty per cent. of these fluids, one can easily see from the results reported that the retarding action upon the solvent or digestive power of the gastric juice must be very considerable, owing to the action of the extractives they contain. Taken in small quantities, on the other hand, these malt liquors are without any marked effect upon the proteolytic action of the gastric juice.

The inhibitory action of these fluids is to be compared with the inhibitory action of such beverages as tea and coffee, the retarding action of which is equally pronounced or even greater when the latter are consumed in large quantities. In this connection it seems no more than proper to add that the extractives or solid matters ordinarily present in malt liquors are not especially peculiar in possessing this retarding action upon pepsin-proteolysis. It is, indeed, a property shared by many substances, and does not in itself necessarily constitute an evil of any great magnitude, unless the retardation is very pronounced and liable to be long continued. Then, indeed, it may become a serious evil, and one sufficient to condemn the substance which causes it.

Comparative Action of Some Alcoholic Liquors on Pepsin-proteolysis.

The following tables, the figures of which are taken from experiments already recorded, may serve to show the relative

action of given percentages of the more common alcoholic liquors on the solvent power of the gastric juice, the results in each table having been obtained under exactly similar conditions: —

Per cent. of liquor in each digestive mixture.	Relative proteolytic action.	
	Sherry.	Beer.
0 per cent.	100.0	100.0
1 "	95.5	101.1
3 "	94.8	98.3
	Sherry.	Beer.
0 per cent.	100.0	100.0
3 "	97.4	100.3
6 "	96.5	98.0
	Whiskey	Brandy.
0 per cent.	100.0	100.0
1 "	100.3	100.6
3 "	100.0	99.7
6 "	98.4	99.8
	Brandy.	Sherry.
0 per cent.	100.0	100.0
10 "	97.0	90.8
	Whiskey.	Hochheimer.
0 per cent.	100.0	100.0
10 "	99.1	97.2
	Claret.	Porter.
0 per cent.	100.0	100.0
1 "	100.9	96.2
3 "	96.6	95.0
6 "	98.0	94.4
	Stout.	Ale.
0 per cent.	100.0	100.0
1 "	100.8	98.3
3 "	98.8	97.7
6 "	96.4	95.1
	Bock-beer.	Hochheimer.
0 per cent.	100.0	100.0
1 "	100.5	100.6
3 "	98.4	98.2
6 "	97.9	96.2

Before leaving this phase of our subject it may be wise to emphasize again the exact scope of these experiments. It is to be remembered that the results here recorded are capable merely of throwing light upon the influence of the various

alcoholic beverages on the digestive or solvent power of the gastric juice. They are not broadly applicable to a determination of the influence of the liquors in question on gastric digestion, since they afford no light as to the influence of these fluids upon the secretion of gastric juice, or upon the mechanical movements of the stomach, or upon the process of absorption. Hence, if we are to be governed by facts, we are not as yet ready to draw any broad generalizations as to the influence of alcoholic liquors upon gastric digestion. We must at present confine ourselves to the influence of these liquors upon the solvent or digestive action of pepsin-hydrochloric acid or gastric juice, and upon this question the results here recorded speak fully and clearly.

B. PANCREATIC DIGESTION.

In studying the influence of alcoholic fluids upon pancreatic digestion our experiments have been limited mainly to the proteolytic action, or albumin-digesting power, of the fluid, since this may be considered as the most important digestive function of the secretion. Further, in our experiments with saliva, to be detailed later on, we have acquired all that seems necessary for us to know regarding the influence of alcoholic fluids upon the starch-digesting power of the amylolytic ferments common to both the saliva and the pancreatic fluid. So far as our knowledge at present extends, there is no difference between the saliva and pancreatic juice in their digestive action on farinaceous foods, so that what is found true with regard to the amylolytic action of the saliva is also applicable to the pancreatic fluid. Hence, in studying pancreatic digestion, our experiments have been limited to the influence of alcoholic fluids upon the tryptic ferment which is so characteristic of this secretion.

The natural secretion from the pancreatic gland has an alkaline reaction, but in the small intestine pancreatic digestion is as liable to be carried on in a neutral reacting fluid as in an alkaline medium, and as our experiments were designed mainly to show the action of the various alcoholic fluids upon the digestive power of the ferment, it seemed best to use a neutral reacting pancreatic juice. The latter was prepared, according to the method originally suggested by Kühne, from dried pan-

creas which had been previously extracted with alcohol and ether.[1] Forty grams of the prepared pancreas were warmed at 40° C. for twenty-four hours with 500 c. c., 0.1 per cent. salicylic acid, the solution filtered and neutralized with dilute sodium carbonate and then diluted with water to 1000 or 1500 c. c. In order to prevent the possibility of putrefactive changes, crystals of thymol were kept floating on the fluid.

In testing the digestive or proteolytic action of the pancreatic juice under the various conditions set forth, 1 gram of dry, pulverized blood-fibrin was weighed out into a suitable flask, 25 c. c. of water containing sufficient of the alcoholic liquor to give the desired percentage to the whole mixture were then added, followed by 25 c. c. of the neutral pancreatic juice, thus making a total volume of 50 c. c. for each mixture. The mixtures of each series were then placed in the same water-bath at 38°–40° C., where they were kept at the body-temperature for six to seven hours with frequent shaking,[2] the flasks being tightly stopped. At the end of the given period the undissolved fibrin was filtered off on weighed filter-papers, washed thoroughly with warm water, and then dried at 110° C. until of constant weight. In this manner it was possible to measure very accurately the influence of various forms and quantities of alcoholic liquors upon the pancreatic digestion of proteid foods.

In view of the position which pancreatic digestion occupies in the digestive process, it is readily seen that it is more desirable to ascertain the influence of small quantities of alcoholic liquors than large amounts, since absorption must naturally lead to a decided diminution of alcohol, etc., before these fluids can normally become mixed with the pancreatic juice and partially digested food-material in the small intestine. Hence, we have laid more stress, as a rule, upon the influence of small percentages of the various fluids experimented with, and only occasionally have tried the action of large quantities.

[1] *Untersuchungen aus der physiol. Institute d. Universität Heidelberg*, i. 222.

[2] Each mixture contained a trace of thymol and sodium salicylate sufficient to prevent putrefaction.

Action of Absolute Alcohol (99.5–100 Per Cent.).

Experiment 80.

Period of digestion seven hours.

Absolute alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.[1]	0.5677 gram.	43.3 per cent.	100.0
2 "	0.6102 "	39.0 "	90.0
5 "	0.6574 "	34.3 "	79.2
10 "	0.7394 "	26.1 "	60.2
20 "	0.8445 "	15.6 "	36.0

Experiment 81.

Period of digestion six hours.

Absolute alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3467 gram.	65.33 per cent.	100.0
0.25 "	0.3375 "	66.25 "	101.4
0.50 "	0.3563 "	64.37 "	98.5
1.00 "	0.3599 "	64.01 "	97.9
2.00 "	0.3521 "	64.79 "	99.2
3.00 "	0.3780 "	62.20 "	95.2

Experiment 82.

Period of digestion six hours.

Absolute alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3058 gram.	69.42 per cent.	100.0
1 "	0.3220 "	67.80 "	97.6
3 "	0.3689 "	63.11 "	90.9
5 "	0.3888 "	61.12 "	88.0
10 "	0.5080 "	49.20 "	70.8
15 "	0.5931 "	40.69 "	58.6
20 "	0.7012 "	29.88 "	43.0

These results with absolute alcohol indicate that the proteolytic ferment of the pancreatic juice is more sensitive to absolute alcohol than the ferment of the gastric juice. Retardation of digestive action is more pronounced even with small amounts of alcohol. Further, as in the case with pepsin, the weaker the digestive powers of the pancreatic juice the greater the retarding action of absolute alcohol. This is clearly seen in comparison of Experiments 80 and 82, and is quite in harmony with what is known regarding the general nature of

[1] The percentage of fluid added is in every instance given by volume unless otherwise specified.

the digestive ferments, or enzymes. When the amount of alcohol present in the digesting mixture is less than one per cent., the retardation of digestive action is very slight, provided the ferment is fairly vigorous in its action.

Whiskey (with 50 Per Cent. of Alcohol).

Experiment 83.

Period of digestion 8 hours.

Whiskey.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5147 gram.	48.6 per cent.	100.0
1 "	0.5390 "	46.1 "	94.8
3 "	0.5556 "	44.5 "	91.5
5 "	0.5635 "	43.7 "	89.9
10 "	0.5972 "	40.3 "	82.9
Absolute alcohol.			
5 per cent.	0.5621 "	43.8 "	90.1

Experiment 84.

Period of digestion $7\frac{1}{4}$ hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3272 gram.	67.3 per cent.	100.0
10 " whiskey	0.4002 "	60.0 "	89.1
10 " " distil.	0.3860 "	61.4 "	91.2
10 " " residue	0.3360 "	66.4 "	98.6
5 " absol. alcohol	0.3858 "	61.5 "	91.3

From these results it is plain that even small amounts of whiskey are detrimental to the digestive action of pancreatic juice on proteid foods. The sensitiveness of the enzyme to this form of alcoholic liquor is quite marked. Further, it is to be noticed that, as with alcohol, the weaker the digestive fluid the stronger is the retarding action of the whiskey. It is also seen that the inhibition produced by a given percentage of whiskey is somewhat greater than that caused by a corresponding percentage of alcohol, thus indicating that there must be some other retarding agent aside from the alcohol present in the whiskey. The general character of this substance is apparent when we compare the action of the distillate and the residue from a given volume of whiskey with that of the whiskey itself.

Thus, the distillate, i. e., the volatile matter of the whiskey, causes less retardation of digestive action than the whiskey itself, although its action is exactly equal to that of a corre-

sponding strength of absolute alcohol. Hence, the difference in action must be attributed to the character of the solid matter present in the liquor, even though the amount present is small.[1] The experiment, indeed, shows that the residue has a sufficient inhibitory action upon tryptic digestion to account fully for the difference in action between whiskey and a corresponding strength of alcohol. As the whiskey residue is decidedly acid in reaction, and the tryptic ferment is well known to be sensitive to the presence of acids, it is reasonable to assume that it is the presence of the latter which is the cause in part, at least, of the greater inhibitory action of the whiskey over that of corresponding strengths of alcohol.

Influence of So-called Fusel Oils on the Proteolytic Action of Pancreatic Juice.

As already described under the head of gastric digestion, whiskey, brandy, and other distilled liquors of this class are supposedly liable to contamination with so-called fusel oils, of which the higher alcohols are the chief constituents.

We have therefore studied the influence of a number of representative alcohols of this type upon trypsin-proteolysis with a view to ascertaining what effect their possible presence in whiskeys and other like liquors might have upon the rate of pancreatic digestion.[2]

Amyl Alcohol.

Experiment 85.

Period of digestion 6 hours.

Amyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4090 gram.	59.1 per cent.	100.0
0.05 "	0.4113 "	58.8 "	99.6
0.10 "	0.4117 "	58.8 "	99.5
0.25 "	0.4149 "	58.5 "	99.0
0.50 "	0.4200 "	58.0 "	98.1
1.00 "	0.4740 "	52.6 "	89.0
2.00 "	0.5140 "	48.6 "	82.2

[1] The whiskey contained about 0.3 per cent. of solid matter.

[2] These experiments were carried out in our laboratory by Edward E. Brownell, Ph. B.

Experiment 86.

Period of digestion 6 hours.

Amyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3107 gram.	68.9 per cent.	100.0
0.05 "	0.3153 "	68.4 "	99.1
0.10 "	0.3442 "	65.5 "	95.1
0.25 "	0.3350 "	66.5 "	96.4
0.50 "	0.3462 "	65.3 "	94.8
1.00 "	0.4027 "	59.7 "	86.6
2.00 "	0.4598 "	54.0 "	78.3

Isobutyl Alcohol.

Experiment 87.

Period of digestion 6 hours.

Isobutyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4185 gram.	58.1 per cent.	100.0
0.05 "	0.4282 "	57.1 "	98.3
0.10 "	0.4305 "	56.9 "	97.9
0.25 "	0.4360 "	56.4 "	97.0
0.50 "	0.4478 "	55.2 "	94.9
1.00 "	0.4491 "	55.0 "	94.7
2.00 "	0.4827 "	47.5 "	81.7

Experiment 88.

Period of digestion 6 hours.

Isobutyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3776 gram.	62.2 per cent.	100.0
0.05 "	0.3796 "	62.0 "	99.7
0.10 "	0.3890 "	61.1 "	98.1
0.25 "	0.3864 "	61.3 "	98.5
0.50 "	0.4116 "	58.8 "	94.5
1.00 "	0.4230 "	57.7 "	92.7
2.00 "	0.4561 "	54.3 "	81.5

Experiment 89.

Period of digestion 6 hours.

Isobutyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2980 gram.	70.2 per cent.	100.0
1 "	0.3334 "	66.6 "	94.9
3 "	0.4052 "	59.4 "	84.7
5 "	0.5431 "	45.6 "	65.0
10 "	0.7333 "	26.6 "	37.9
15 "	0.7743 "	22.5 "	32.1
20 "	0.7813 "	21.8 "	31.1

Propyl Alcohol.

Experiment 90.

Period of digestion 6 hours.

Propyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4096 gram.	59.0 per cent.	100.0
0.05 "	0.4088 "	59.1 "	100.1
0.10 "	0.4081 "	59.2 "	100.2
0.25 "	0.4100 "	59.0 "	99.9
0.50 "	0.4159 "	58.4 "	98.7
1.00 "	0.4333 "	56.6 "	95.9
2.00 "	0.4336 "	56.6 "	95.9

Experiment 91.

Period of digestion 6 hours.

Propyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3920 gram.	60.8 per cent.	100.0
0.05 "	0.3702 "	62.9 "	103.6
0.10 "	0.3875 "	61.2 "	100.7
0.25 "	0.3946 "	60.5 "	99.5
0.50 "	0.4030 "	59.7 "	98.2
1.00 "	0.4082 "	59.1 "	97.3
2.00 "	0.4210 "	57.9 "	95.2

Experiment 92.

Period of digestion 6 hours.

Propyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3486 gram.	65.1 per cent.	100.0
1 "	0.3420 "	65.8 "	101.0
3 "	0.3900 "	61.0 "	93.6
5 "	0.4456 "	55.4 "	85.1
10 "	0.6032 "	39.6 "	60.9
15 "	0.7850 "	21.5 "	33.0
20 "	0.9255 "	7.4 "	11.4

Methyl Alcohol.

Experiment 93.

Period of digestion 6 hours.

Methyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3850 gram.	61.5 per cent.	100.0
0.25 "	0.3832 "	61.8 "	100.3
0.50 "	0.3931 "	60.7 "	98.7
1.00 "	0.3813 "	61.8 "	100.6
2.00 "	0.3812 "	61.8 "	100.6
3.00 "	0.3862 "	61.3 "	99.7

Experiment 94.

Period of digestion 6 hours.

Methyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3423 gram.	65.7 per cent.	100.0
1 "	0.3702 "	62.9 "	95.7
3 "	0.4143 "	58.5 "	89.2
5 "	0.4237 "	57.6 "	87.7
10 "	0.5253 "	47.4 "	72.3
15 "	0.6195 "	38.0 "	56.3
20 "	0.7170 "	28.3 "	43.0

The following experiment was designed to show the *comparative* action of methyl, ethyl, propyl, and isobutyl alcohols upon trypsin-proteolysis. The period of digestion was six hours at 38°–40° C.

Experiment 95.

Alcohol added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3117 gram.	68.8 per cent.	100.0
5 " methyl	0.3968 "	60.3 "	87.6
5 " ethyl	0.4081 "	59.2 "	86.0
5 " propyl	0.4620 "	53.8 "	78.1
5 " isobutyl	0.5183 "	48.2 "	70.0
15 " methyl	0.5926 "	40.7 "	59.1
15 " ethyl	0.6213 "	37.8 "	54.9
15 " propyl	0.8155 "	18.4 "	26.7
15 " isobutyl	0.8024 "	19.7 "	28.6

A careful scrutiny of all the foregoing results obtained with the alcohols liable to be present in so-called fusel oils shows that their inhibitory action upon trypsin-proteolysis is somewhat greater than that of ordinary ethyl alcohol. When it is considered, however, that they can at the most be present in whiskeys, brandies, and the like only in very small quantities, it is apparent that their retarding action can have little practical influence in modifying ordinary proteolytic action. Physiologically, however, the results obtained in Experiment 95 are extremely interesting, since they tend to show that the retarding action of these alcohols on trypsin-proteolysis increases with the weight of the alcohol. Thus, in digestive mixtures containing five per cent. of these alcohols, the lowest member of the series, methyl alcohol, has the least inhibitory action, while isobutyl alcohol, the highest alcohol tested, has the greatest retarding

effect. If these alcohols were present in any quantity in alcoholic liquors, their retarding action on trypsin-proteolysis would unquestionably be a very important factor; but as there is no evidence that they are ever present in more than traces, their action in this direction can have little practical importance.

Brandy (with 48 Per Cent. of Alcohol).

Experiment 96.

Period of digestion $7\frac{5}{12}$ hours.

Brandy.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5531 gram.	44.7 per cent.	100.0
1 "	0.5701 "	43.0 "	96.1
3 "	0.5808 "	42.0 "	93.9
5 "	0.5812 "	41.9 "	93.7
10 "	0.6131 "	38.7 "	86.5
Absolute alcohol.			
5 per cent.	0.6135 "	38.7 "	86.5

Experiment 97.

Period of digestion 8 hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2974 gram.	72.1 per cent.	100.0
10 " brandy	0.3522 "	64.8 "	89.8
10 " " distil.	0.3635 "	63.7 "	88.3
10 " " residue	0.3083 "	69.2 "	95.9
5 " absol. alcohol	0.3475 "	65.3 "	90.5

Here we have much the same results as were obtained with whiskey. Thus, retardation of proteolysis is quite pronounced with ten per cent. of brandy, but with one per cent. it is comparatively slight. Unlike whiskey, however, the action of the brandy is due almost entirely to the alcohol it contains, although the solid matter present in it has some retarding action.

Rum (with 51 Per Cent. of Alcohol).

Experiment 98.

Period of digestion $7\frac{5}{6}$ hours.

Rum.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5611 gram.	43.9 per cent.	100.0
1 "	0.5805 "	42.0 "	95.6
3 "	0.6077 "	39.3 "	89.5
5 "	0.6230 "	37.7 "	85.8
10 "	0.6661 "	33.4 "	76.0
Absolute alcohol.			
5 per cent.	0.6339 "	36.7 "	83.5

Experiment 99.

Period of digestion 8 hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2794 gram.	72.1 per cent.	100.0
10 " rum	0.3620 "	63.8 "	88.0
10 " " distil.	0.3562 "	64.4 "	89.3
10 " " residue	0.2974 "	70.3 "	97.5
5 " absol. alcohol	0.3475 "	65.3 "	90.5

With rum, retardation of proteolysis is quite pronounced in the presence of even five per cent. of the liquor, although, as in other cases, the exact amount of retardation is dependent largely upon the strength or activity of the pancreatic juice. Further, while the retarding action is due mainly to the contained alcohol, yet it is evident that the solid matter of the rum has a somewhat deleterious influence, the two factors combining to cause the slow digestive action of mixtures containing five and ten per cent. of rum.

If one should attempt a comparison of the action of these strong alcoholic liquors upon pepsin-proteolysis and trypsin-proteolysis, the conclusion, we think, would be that pepsin-hydrochloric acid is far less sensitive to the action of these alcoholic fluids than trypsin. The latter is far more liable to be retarded in its digestive activity than pepsin by small amounts of these fluids. Further, in trypsin-proteolysis there is not quite so close a relationship between the extent of retardation and the content of alcohol in the fluid under examination. In other words, the tryptic ferment is not only more sensitive to the action of alcohol, but it is likewise more inclined to be affected by the various extractives, especially the acid-reacting bodies, present in these liquors than is the case with pepsin.

Sherry (with 21 Per Cent. of Alcohol and 4.7 Per Cent. of Solid Matter).

Experiment 100.

Period of digestion $8\frac{1}{2}$ hours.

Sherry.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5246 gram.	47.6 per cent.	100.0
1 "	0.5473 "	45.3 "	95.1
3 "	0.5803 "	42.0 "	88.2
5 "	0.6200 "	38.0 "	79.8
10 "	0.7128 "	28.8 "	60.5
Absolute alcohol.			
2 per cent.	0.5776 "	42.3 "	88.8

Experiment 101.

Period of digestion $7\frac{1}{4}$ hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3272 gram.	67.3 per cent.	100.0
10 " sherry	0.4452 "	55.5 "	82.4
10 " " distil.	0.3678 "	63.3 "	94.0
10 " " residue	0.4082 "	59.2 "	87.9
5 " absol. alcohol	0.3858 "	61.5 "	91.3

Claret (with 10 Per Cent. of Alcohol and 3.3 Per Cent. of Solid Matter).

Experiment 102.

Period of digestion $7\frac{1}{2}$ hours.

Claret.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5799 gram.	42.1 per cent.	100.0
1 "	0.5966 "	40.4 "	95.9
3 "	0.6475 "	35.3 "	86.2
5 "	0.6963 "	30.4 "	72.2
10 "	0.8539 "	14.7 "	34.9
Absolute alcohol.			
2 per cent	0.6020 "	39.8 "	94.5

Experiment 103.

Period of digestion 6 hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3604 gram.	64.0 per cent.	100.0
10 " claret	0.5842 "	41.6 "	65.0
10 " " distil.	0.3963 "	60.4 "	94.3
10 " " residue	0.5403 "	46.0 "	71.8
1 " absol. alcohol	0.3973 "	60.3 "	94.2

Hochheimer (with 11 Per Cent. of Alcohol and 1.8 Per Cent. of Solid Matter).

Experiment 104.

Period of digestion $8\frac{1}{2}$ hours.

Hochheimer.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5325 gram.	46.8 per cent.	100.0
3 "	0.5991 "	40.1 "	85.6
5 "	0.6357 "	36.5 "	77.9
10 "	0.7564 "	24.4 "	52.1
Absolute alcohol.			
1 per cent.	0.5785 "	42.2 "	90.1

Experiment 105.

Period of digestion 6 hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3604 gram.	64.0 per cent.	100.0
10 " hochheimer	0.5267 "	47.4 "	74.0
10 " " distil.	0.3993 "	60.1 "	93.9
10 " " residue	0.4760 "	52.4 "	81.8
1 " absol. alcohol	0.3973 "	60.3 "	94.2

Comparative Action of Strong Liquors and Wines.

Experiment 106.

Period of digestion $7\frac{1}{4}$ hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5945 gram.	40.6 per cent.	100.0
5 " absol. alcohol	0.6622 "	33.8 "	83.2
10 " whiskey	0.6844 "	31.6 "	77.8
10 " brandy	0.6465 "	35.4 "	87.1 [1]
10 " rum	0.6818 "	31.9 "	78.5
10 " sherry	0.7506 "	25.0 "	61.5
10 " hochheimer	0.7850 "	21.5 "	52.9
10 " claret	0.8533 "	14.7 "	36.2

Considering now the import of the results obtained by our study of the action of these wines upon trypsin-proteolysis, it is evident that these fluids have a far greater inhibitory action than the stronger liquors, such as whiskey, brandy, etc. Further, it is plain that the action of any given wine upon the tryptic digestion of proteid foods is quite independent of its

[1] This result is presumably too high, although we know of no cause of error.

content of alcohol. Retardation of digestive action is out of all proportion to the alcohol present in the fluid. Contrast, for example, the action of claret, with the smallest percentage of alcohol, with that of sherry, which contains double the amount of alcohol. Further, between claret and the white wine (hochheimer) there is a wide difference in inhibitory action, although the difference in the content of alcohol amounts to only one per cent. The alcohol present in these wines plainly exerts a retarding influence upon proteolysis, as is apparent from the results obtained with the distillates from the respective fluids, and in this connection it is to be noted that the retardation produced by the distillates from both claret and hochheimer is essentially the same, and, moreover, is practically identical with the retardation caused by a corresponding percentage of absolute alcohol.

The greater part of the retardation produced by these wines, however, is clearly connected with the character of the solid matter present in the fluids. Thus, it is to be noted that there is no close relationship, at least, between the amount of solid matter in the wine and its inhibitory action. We therefore sought for some explanation of the above results in the specific character of this solid or non-volatile matter, and our conclusion is that the retardation is due in great part to the amount of free acid and acid salts contained in the respective fluids; a conclusion which will apply not only to the wine residues, but likewise to the solid matter contained in the stronger alcoholic fluids.

The acidity of these fluids was determined by neutralization of a given volume with a standard solution of potassium hydroxide, containing 0.2 per cent. KOH. The relative acidity is indicated by the following figures, which show the number of cubic centimetres of the alkali solution required to neutralize 25 c. c. of the respective liquors: —

25 c. c.	brandy	required	3.0	c. c.	alkali solution.
25 "	whiskey	"	3.5	"	"
25 "	rum	"	15.0	"	"
25 "	sherry	"	58.5	"	"
25 "	hochheimer . . .	"	80.3	"	"
25 "	claret	"	87.0	"	"

Trypsin, the proteolytic ferment of the pancreatic juice, is well known to be extremely sensitive to the presence of acids,

and when this fact is remembered we have, perhaps, in the above data, a full explanation of the marked retardation of trypsin-proteolysis caused by the above acid wines: a retardation far greater than that caused by the alcohol contained in them. Further, the inhibitory action on tryptic digestion produced by the solid matter present in whiskey, brandy, and rum is likewise to be assigned, in part at least, to this same cause. In addition to this possible explanation it must also be remembered that many neutral salts, such as are liable to be present in these liquors, likewise have an inhibitory action on proteolytic enzymes.

Lager Beer (with 1.5 Per Cent. of Alcohol and 7 Per Cent. of Solid Matter).

Experiment 107.

Period of digestion 8 hours.

Beer.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5388 gram.	46.2 per cent.	100.0
1 "	0.5596 "	44.1 "	95.4
3 "	0.5769 "	42.4 "	91.7
5 "	0.5817 "	41.9 "	90.7
10 "	0.6147 "	38.6 "	83.5

Experiment 108.

Period of digestion $7\frac{1}{12}$ hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3203 gram.	68.0 per cent.	100.0
10 " beer	0.3602 "	64.0 "	94.1
10 " " distil.	0.3487 "	65.2 "	95.8
10 " " residue	0.3480 "	65.2 "	95.8
1 " absol. alcohol	0.3439 "	65.7 "	96.6

Porter (with 3.7 Per Cent. of Alcohol and 4.4 Per Cent. of Solid Matter).

Experiment 109.

Period of digestion $7\frac{3}{4}$ hours.

Porter.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5102 gram.	49.0 per cent.	100.0
1 "	0.5095 "	49.1 "	100.2
3 "	0.5101 "	49.0 "	100.0
5 "	0.5267 "	47.4 "	96.7
10 "	0.5834 "	41.7 "	85.1
Absolute alcohol.			
1 per cent.	0.5318 "	46.9 "	95.7

Experiment 110.

Period of digestion $5\frac{7}{12}$ hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3919 gram.	60.9 per cent.	100.0
1 " porter	0.4059 "	59.5 "	97.7
10 " "	0.4719 "	52.9 "	86.8
10 " " distil.	0.4071 "	59.3 "	97.3
10 " " residue	0.4163 "	58.4 "	95.8
1 " absol. alcohol	0.4015 "	59.9 "	98.3

Bass's Ale (with 4 Per Cent. of Alcohol and 4.4 Per Cent. of Solid Matter).

Experiment 111.

Period of digestion $7\frac{7}{12}$ hours.

Ale.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4671 gram.	53.3 per cent.	100.0
1 "	0.4624 "	53.8 "	100.9
3 "	0.4949 "	50.6 "	94.9
5 "	0.5160 "	48.4 "	90.8
10 "	0.5311 "	46.9 "	87.9

Experiment 112.

Period of digestion $7\frac{1}{12}$ hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3203 gram.	68.0 per cent.	100.0
10 " ale	0.3772 "	62.3 "	91.6
10 " " distil.	0.3386 "	66.2 "	97.3
10 " " residue	0.3684 "	63.2 "	92.9
1 " absol. alcohol	0.3439 "	65.7 "	96.6

The following experiment shows the comparative action of these malt liquors when tested under exactly the same conditions: —

Experiment 113.

Period of digestion 5 hours.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3919 gram.	60.9 per cent.	100.0
10 " beer	0.4466 "	55.4 "	90.9
10 " ale	0.4686 "	53.2 "	87.3
10 " porter	0.4719 "	52.9 "	86.8
1 " absol. alcohol	0.4015 "	59.9 "	98.3

From these results it is manifest that the malt liquors, as re-

presented by the above samples, have far less retarding action on trypsin-proteolysis than do wines. This fact, however, is not connected with the smaller content of alcohol, but rather with the amount and character of the extract or solid matter of the fluid. Thus, lager beer, with only 1.5 per cent. of alcohol, when present in small amount, has a greater retarding action than either porter or ale, although these fluids contain three to four per cent. of alcohol. The beer, however, contains nearly twice as much solid matter as the other fluids, and its greater inhibitory power is presumably due to this cause. Small amounts of porter and ale have no noticeable retarding action whatever, but the presence of five or ten per cent. of either of these malt liquors leads to a decided diminution of digestive power.

None of these malt liquors was very strongly acid; thus, the acidity of the ale was only slightly above that of the sample of rum, while the lager beer was considerably less acid. The porter alone was strongly acid, its acidity being nearly half that of the sherry wine. Plainly, the acidity of these malt fluids is not a very important factor in their retarding action on trypsin-proteolysis.

Doubtless, many non-alcoholic beverages have an equally pronounced inhibitory action on the digestive processes, owing to the presence of inorganic salts and other extractives. Tea and coffee, owing to the tannin they contain, are known to exert such an influence, and we may cite the following experiment with ginger ale as an illustration of inhibitory action caused presumably by the extractive matters contained therein:

Experiment 114.

Period of digestion 7 hours.

Ginger ale.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3260 gram.	67.4 per cent.	100.0
1 "	0.3553 "	64.5 "	95.7
3 "	0.3574 "	64.3 "	95.4
5 "	0.3562 "	64.4 "	95.5
10 "	0.3866 "	61.4 "	91.0
Absolute alcohol.			
1 per cent.	0.3361 "	66.4 "	98.5

In contrast to this experiment, we report the following results obtained with bottled "soda water"; i. e., water simply

charged with carbonic acid gas, which may be offered as evidence that it is possible to have pancreatic digestion without retardation.

Experiment 115.

Period of digestion $6\frac{1}{3}$ hours.

Soda water.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4692 gram.	53.1 per cent.	100.0
1 "	0.4695 "	53.1 "	100.0
3 "	0.4675 "	53.3 "	100.3
5 "	0.4690 "	53.1 "	100.0

Comparative Action of Some Alcoholic Liquors on Trypsin-proteolysis.

The comparative action of some of these alcoholic liquors may be seen from the following results, which are taken from preceding experiments, where all of the conditions were strictly comparable: —

Per cent. of alcoholic fluid in digestive mixture.	Relative proteolytic action.		
	Rum.	Brandy.	Proof spirits.
0 per cent.	100.0	100.0	100.0
10 "	88.0	89.8	90.5
	Whiskey.	Sherry.	
0 per cent.	100.0	100.0	
10 "	89.1	82.4	
	Claret.	Hochheimer.	
0 per cent.	100.0	100.0	
10 "	65.0	74.0	
	Beer.	Ale.	
0 per cent.	100.0	100.0	
10 "	94.1	91.6	

In concluding this chapter of our subject, we may repeat that distilled alcoholic liquors, such as whiskey, brandy, etc., have a far greater retarding action upon trypsin-proteolysis than upon pepsin-proteolysis. Further, this retardation is not due wholly to the contained alcohol, but is attributable in part to the solid matter present. This latter, however, in a distilled liquor should obviously be very small, and it is quite apparent that if due care is used in the distillation and rectification of such a liquor and no additions are made, the only solid matter should be such as is extracted from the cask in which the liquor is stored. The liquors in question, however, did contain some

extractive matter other than tannin, and to this material, as well as to the tannin and the alcohol, the retardation of trypsin-proteolysis is unquestionably due. Wines, with their high acidity and low alcoholic strength, exert a retarding action on tryptic digestion more nearly proportional to the acidity than to the amount of alcohol, or even to their content of solid matter. All three of these elements, however, undoubtedly combine to produce the results recorded. The malt liquors, on the other hand, owe their retarding influence mainly to the large percentage of extractives of various sorts which they contain, the alcohol playing a minor part in the inhibition caused by the fluids of this class.

C. SALIVARY DIGESTION.

In considering the influence of alcoholic beverages on salivary digestion, it is to be remembered that the latter process has for its main object the digestion of the farinaceous foods. This property is shared in common with the pancreatic juice, the utilization of all farinaceous foods by the body being dependent almost wholly upon the so-called amylolytic power of these two secretions.

Salivary digestion is a comparatively rapid process, the transformation of the insoluble starch into soluble dextrins and sugar taking place in a relatively short period, as contrasted with the proteolytic action of either the gastric or pancreatic juice. Amylaceous or farinaceous foods are exposed to the action of the saliva in the mouth for only a short interval, but the evidence at present available points to the probable continuation of salivary digestion in the stomach for from ten to thirty minutes before the amylolytic ferment is killed by the increasing acidity of the gastric juice. In view of this relatively short period of digestion, retardation of amylolytic action may become a serious matter, since even slight retardation may mean the loss of more or less nutriment to the body. The amylolytic ferment of the pancreatic juice, however, may be able to convert the unchanged starch in the small intestine, providing the influence of the retarding agent does not extend so far. But in any event, retardation or stoppage of salivary digestion must be a serious evil, and it is to be remembered that the amylolytic ferment of the pancreatic juice is closely akin to, if not identical

with, the ferment of the saliva, and hence is susceptible to the same influences that affect the salivary ferment.

Methods employed.

In testing the influence of alcoholic liquors on the salivary digestion of starchy foods, the following method was most generally employed: Ten c. c. of a freshly prepared starch-paste (one per cent.) were introduced into a suitable flask, a given volume of the alcoholic fluid together with sufficient water to make the resultant mixture up to 90 c. c., added, and lastly, 10 c. c. of neutralized and filtered saliva, which had been previously diluted to some definite volume. The completed mixture was thus composed of 100 c. c. The time at which the saliva was added was carefully noted, and the mixture placed in a suitable water-bath kept at 38°–40° C. In order to measure the rate of digestion a drop of fluid was withdrawn at intervals, placed on a white porcelain surface, and tested with a drop of a dilute iodine solution. The color obtained with iodine under these conditions is dependent upon the extent of amylolytic action. Thus, the presence of soluble starch, the first product formed, is indicated by a blue color. As digestion proceeds, the blue color gives place to a reddish color with iodine, owing to the presence of erythrodextrin, while the final products of amylolytic action, maltose and achroödextrins, give no color whatever with iodine. The time when this so-called "achromic" point is reached is carefully noted, and the number of minutes required for the appearance of the "achromic" point serves as a measure of the rate of amylolytic action.

A method less frequently used in our experiments, but better adapted to measuring accurately small shades of difference, was as follows: One gram of arrowroot starch was made into a paste with 40 c. c. of water, 50 c. c. of water alone (in the control) or with the required volume of alcoholic fluid to give the desired percentage were then added, and lastly, 10 c. c. of a diluted neutral saliva. The mixture, or series of mixtures, was then placed in a bath at 38°–40° C. for thirty minutes, after which the solution was heated to boiling to prevent further action of the enzyme. The resultant solution was then made up to 150 c. c., and the extent of amylolytic action ascertained

by determining in one sixth of the solution the amount of maltose formed by the use of Allihn's[1] gravimetric method. From the amount of reduced copper thus obtained, the amount of maltose was calculated on the basis of Salomon's[2] statement that 100 parts of anhydrous maltose will form 114 parts of reduced copper when boiled with Fehling's solution after the Allihn method.

It is, of course, understood that in both methods all of the mixtures belonging to a given series were treated with the same specimen of saliva.

Absolute Alcohol (99.5 to 100 Per Cent.).

Experiment 116. (Saliva 1 : 15.)[3]

Alcohol.	Appearance of the achromic point.
0 per cent.	7 minutes.
0.5 "	7 "
1.0 "	7 "
2.0 "	7 "
5.0 "	7 "
10.0 "	7 "

Experiment 117. (Saliva 1 : 20.)

Alcohol.	Appearance of the achromic point.
0 per cent.	7 minutes.
1 "	7 "
10 "	7 "

Experiment 118. (Saliva 1 : 30.)

Alcohol.	Appearance of the achromic point.
0 per cent.	27 minutes.
0.5 "	27 "
1.0 "	27 "
2.0 "	27 "
5.0 "	27 "
10.0 "	25 "

From these results it is plainly manifest that absolute alcohol has very little influence upon the amylolytic or starch-digesting

[1] *Zeitsch. f. Analyt. Chemie,* xxii. 448.

[2] *Journal für Praktische Chemie,* xxviii. 109.

[3] Being the dilution of the saliva added to the digesting mixture ; i. e., one part of fresh saliva in fifteen parts of water. It is to be remembered, however, that in the digestive mixtures (100 c. c.) the dilution of the saliva is increased tenfold.

power of neutral saliva. Only when the saliva, added to the digestive mixture, is diluted in the proportion of 1 to 30 does the presence of even ten per cent. of alcohol have any measurable influence, and then only to retard the appearance of the achromic point two minutes. As this percentage of absolute alcohol is equal to at least twenty per cent. of proof spirit, it follows that pure alcohol free from admixture is practically without influence upon the digestion of farinaceous foods by the saliva.

A more accurate testing of this question was attempted by the use of the second method above described, with the following results: —

Experiment 119. (Saliva 1 : 4.)

Alcohol.	Reduced copper in $\frac{1}{5}$.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.0885 gram.	31.05 per cent.[1]	100.0
0.5 "	0.0918 "	32.21 "	103.7
1.0 "	0.0908 "	31.86 "	102.6
3.0 "	0.0911 "	31.96 "	102.9
5.0 "	0.0897 "	31.47 "	101.3
10.0 "	0.0862 "	30.25 "	97.4

Experiment 120. (Saliva 1 : 5.)

Alcohol.	Reduced copper in $\frac{1}{5}$.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.1436 gram.	75.5 per cent.	100.0
5 "	0.1439 "	75.7 "	100.2
10 "	0.1367 "	71.9 "	95.2
15 "	0.1309 "	68.0 "	90.0

Experiment 121. (Saliva 1 : 4.)

Alcohol.	Reduced copper in $\frac{1}{5}$.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.122 gram.	64.2 per cent.	100.0
5 "	0.120 "	63.1 "	98.2
10 "	0.119 "	62.5 "	97.3
15 "	0.114 "	60.0 "	93.4

Experiment 122. (Saliva 1 : 2.)

Alcohol.	Reduced copper in $\frac{1}{5}$.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.132 gram.	69.4 per cent.	100.0
5 "	0.131 "	68.9 "	99.2
10 "	0.126 "	66.3 "	95.5
15 "	0.125 "	65.7 "	94.6

[1] Calculated on the one gram of starch employed.

At first glance these results would seem to be somewhat opposed to those obtained in the first series of experiments, but such is not the case. The first method simply tells us the time when all the starch has been transformed into achroödextrin and maltose. The second method, however, tells us more than this, viz., the actual amount of *maltose* that has been formed, and, as a certain amount of achroödextrin can be transformed into maltose by the continued action of the salivary ferment, it follows that this latter method gives us a clearer knowledge of the influence of alcohol upon the secondary action of the amylolytic enzyme. Thus, we find that small amounts of absolute alcohol may actually cause an increased formation of maltose. On the other hand, the presence of ten or fifteen per cent. of absolute alcohol leads to a distinct retardation in the formation of sugar, although the inhibition is not very pronounced considering the amount of alcohol present. This retardation of the secondary action of the ferment is perhaps suggested by the slight delay in the appearance of the achromic point in Experiment 118, in the presence of ten per cent. of absolute alcohol.

Whiskey (with 50 Per Cent. of Alcohol).

Experiment 123. (Saliva 1 : 30.)

Whiskey.	Appearance of the achromic point.
0 per cent.	28 minutes.
0.5 "	22 hours.
1.0 "	no action beyond erythrodextrin.[1]
2.0 "	no action whatever.[2]
5.0 "	" "

Experiment 124. (Saliva 1 : 25.)

Whiskey.	Appearance of the achromic point.
0 per cent.	6 minutes.
0.5 "	8 "
1.0 "	17 hours.
2.0 "	no action beyond soluble starch.
5.0 "	no action at all.
Absolute alcohol.	
2.5 per cent.	6 minutes.

[1] The final observation was always made at the end of twenty-four hours.
[2] Ibid.

Experiment 125. (Saliva 1 : 20.)

Whiskey.	Appearance of the achromic point.
0 per cent.	7 minutes.
0.5 "	8 "
1.0 "	9 "
2.0 "	no action beyond erythrodextrin.
5.0 "	no action whatever.
Absolute alcohol.	
2.5 per cent.	7 minutes.

Experiment 126. (Saliva 1 : 15.)

Whiskey.	Appearance of the achromic point.
0 per cent.	5 minutes.
0.5 "	5 "
1.0 "	7 "
2.0 "	24 hours.
5.0 "	no action whatever.
Absolute alcohol.	
2.5 "	5 minutes.

Experiment 127. (Saliva 1 : 7.)

Whiskey.	Appearance of the achromic point.
0 per cent.	3 minutes.
2 "	5 "
5 "	no action beyond erythrodextrin.
10 "	no action whatever.
Absolute alcohol.	
5 per cent.	3 minutes.

Experiment 128. (Saliva 1 : 3.)

Whiskey.	Appearance of the achromic point.
0 per cent.	3 minutes.
5 "	4 "
10 "	24 hours.
Absolute alcohol.	
5 per cent.	3 minutes.

Experiment 129. (Saliva 1 : 4.)

Whiskey.	Reduced copper in $\frac{1}{6}$.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.109 gram.	57.3 per cent.	100.0
5 "	0.110[1] "	57.8 "	100.8
10 "	0.080 "	42.0 "	73.3
15 "	0.010 "	5.2 "	9.0

From these results it is apparent that whiskey may have a very great retarding action upon salivary digestion, the retarda-

[1] Allowance being made for the reduction obtained from a corresponding amount of the whiskey alone.

tion being the more pronounced the greater the dilution of the saliva. When, however, the saliva is diluted only three or four times, so that the proportion of saliva in the digestive mixture is as 1 : 30 or 1 : 40, then the presence of even five per cent. of whiskey is wholly without action. It is furthermore apparent that the alcohol of the whiskey plays no part in this inhibitory action. What now is the cause of the retardation? In this connection it is to be remembered that all the whiskeys examined by us have shown an acid reaction; furthermore, the saliva used in our experiments was neutralized saliva. Taking into consideration the well-known sensitiveness of the salivary ferment toward acids, the question naturally presents itself whether this retardation of amylolytic action caused by the whiskey is not due to the acidity of the fluid. This question we attempted to answer by the following experiments: —

Experiment 130. (Saliva 1 : 15.)

Fluid added.	Appearance of the achromic point.
0 per cent.	4 minutes.
2.0 " whiskey	24 hours.
2.0 " " neutralized	7 minutes.
1.0 " absolute alcohol	4 "

Experiment 131. (Saliva 1 : 25.)

Fluid added.	Appearance of the achromic point.
0 per cent.	9 minutes.
1 " whiskey	24 hours.
1 " " neutralized	22 minutes.
5 " "	no action.
5 " " neutralized	partial action.
10 " " "	" "
2.5 " absolute alcohol	11 minutes.

From these results it is apparent that the retarding action of the whiskey is in great part overcome by neutralization of the liquor, providing the saliva is not too greatly diluted. It is furthermore apparent that with unneutralized saliva — i. e., with the normally alkaline secretion — the retarding action of at least small quantities of whiskey would be far less than is indicated by the above results. Indeed, it may be safely said that with a fair volume of unneutralized and not too greatly diluted saliva the presence of even five per cent. of whiskey would be practically without action on the salivary digestion of farina-

ceous foods, a conclusion which Roberts has likewise reached. Obviously, however, the degree of acidity of a given sample of whiskey, together with the natural alkalinity of the saliva, would be important factors in determining the precise character of the result.

In this connection the question may properly be asked why we employed neutralized saliva in our experiments instead of the normally alkaline fluid? To this we would answer that in no other way was it possible to obtain constant and comparable conditions, since the alkalinity of the secretion is ever variable, and, moreover, every variation in the dilution of the fluid would obviously cause a corresponding variation in the degree of alkalinity. Further, the best action of saliva is normally obtained when the fluid is neutral, and the natural tendency of the food-stuffs is toward neutralization of the secretion, both in the mouth and in the stomach. Again, since the fluids we were testing all have an acid reaction, it seemed more probable that we should obtain a trustworthy indication of the action of these fluids upon the amylolytic ferment by using a neutral solution of the enzyme.

In conclusion, then, we may repeat that the retardation of amylolytic action caused by large amounts of whiskey is not closely connected with the amount of alcohol the liquor contains, but is more intimately associated with the presence of volatile, acid-reacting bodies, possibly also ethereal bodies, volatile oils, and perhaps also tannin. Hence, the greater the purity of the whiskey, the less will be its retarding action upon the digestion of the farinaceous food-stuffs.

That the solid, non-volatile portions of the whiskey that we experimented with have no retarding action upon the amylolytic power of the saliva is shown by the following experiment made with the residue left on evaporation of the whiskey, — an experiment which also shows that the acid-reacting bodies present in the whiskey are volatilized by heat: —

Experiment 132. (Saliva 1 : 4.)

Whiskey residue.[1]	Reduced copper in $\frac{1}{6}$.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.091 gram.[2]	47.8 per cent.	100.0
5 "	0.115 "	60.4 "	126.3
10 "	0.113 "	59.4 "	124.2
15 "	0.103 "	54.1 "	113.1

So far as these results go, they indicate that the solid matter present in this sample of whiskey, when free from alcohol and the volatile acid-reacting bodies, has a marked stimulating action upon salivary digestion. Whether this result may be expected from all whiskeys is, of course, uncertain.

Influence of the So-called Fusel Oils upon the Amylolytic Action of Saliva.

Since the preceding results obtained with whiskey indicate that the retarding action of this liquor upon salivary digestion is mainly associated with volatile matters other than ethyl alcohol, we have tried a few experiments[3] with the alcohols liable to be present in the so-called fusel oils with a view to ascertaining their influence upon the amylolytic action of the salivary ferment. As already stated, we have very little personal knowledge concerning the presence of fusel oil in the distilled liquors of the whiskey type. Such tests as we have made in this direction have either given negative results or else have shown the presence of these oils in very small amounts only. Still, as they are generally considered as impurities common to low-grade liquors, it is desirable to know something concerning the action of the alcohols present in them.

Amyl Alcohol.

Experiment 133. (Saliva 1 : 4.)

Amyl alcohol.	Reduced copper in $\frac{1}{6}$.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.1208 gram.	42.3 per cent.	100.0
0.05 "	0.1209 "	42.4 "	100.2
0.10 "	0.1215 "	42.6 "	100.7
0.25 "	0.1234 "	43.2 "	102.1
0.50 "	0.1190 "	41.7 "	98.5
1.00 "	0.1130 "	39.7 "	93.8

[1] The residue dissolved in water. The percentages refer to the residue obtained from those percentages of whiskey.

[2] Deduction being made for the reducing power of the residue itself.

[3] These experiments were carried out in our laboratory by Philip Dowell, B. A., Ph. B.

Isobutyl Alcohol.

Experiment 134. (Saliva 1 : 4.)

Isobutyl alcohol.	Reduced copper in ¼.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.1137 gram.	39.8 per cent.	100.0
0.05 "	0.1122 "	39.3 "	98.7
0.10 "	0.1139 "	39.9 "	100.2
0.25 "	0.1152 "	40.4 "	101.5
0.50 "	0.1119 "	39.2 "	98.4
1.00 "	0.1161 "	40.7 "	102.2

Propyl Alcohol.

Experiment 135. (Saliva 1 : 4.)

Propyl alcohol.	Reduced copper in ¼.	Maltose formed.	Relative amylolytic action.
0 per cent.	—	—	—[1]
0.05 "	0.1238 gram.	43.4 per cent.	100.0
0.10 "	0.1197 "	42.0 "	96.7
0.25 "	0.1288 "	45.1 "	103.9
0.50 "	0.1343 "	47.0 "	108.2
1.00 "	0.1254 "	44.0 "	101.3

Methyl Alcohol.

Experiment 136. (Saliva 1 : 4.)

Methyl alcohol.	Reduced copper in ¼.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.0988 gram.	34.6 per cent.	100.0
0.25 "	0.1005 "	35.2 "	101.7
0.50 "	0.1040 "	36.4 "	105.2
1.00 "	0.1130 "	39.6 "	114.4
2.00 "	0.1042 "	36.5 "	105.4
5.00 "	0.1067 "	37.4 "	108.0

These results make it clear that, if whiskey or other distilled liquor should be contaminated with the above alcohols, their presence in any ordinary amount would not be prejudicial to salivary digestion. In fact, with the exception of amyl alcohol, these bodies, even in the largest percentages employed, tend to increase the amylolytic action of the saliva considerably above that of the control mixture. Physiologically, this fact is of considerable interest, although it does not help explain the cause of the retardation in amylolytic action produced by whiskey, brandy, and the other liquors of this class.

[1] This result was lost through an accident, and consequently the action of the various percentages of alcohol must be compared with the action of the lowest percentage.

Brandy (with 48 Per Cent. of Alcohol).

Experiment 137. (Saliva 1 : 20.)

Brandy.	Appearance of the achromic point.
0 per cent	5 minutes.
0.5 "	7 "
1.0 "	12 "
2.0 "	17 hours.
5.0 "	no action beyond soluble starch and erythrodextrin.
10.0 "	no action whatever.
Absolute alcohol.	
5.0 per cent.	7 minutes.

Experiment 138. (Saliva 1 : 4.)

Brandy.	Reduced copper in ⅛.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.113 gram.[1]	59.4 per cent.	100.0
5 "	0.117 "	61.5 "	103.5
10 "	0.087 "	45.7 "	76.9
15 "	0.051 "	26.8 "	45.1

As with whiskey, brandy is wholly without deleterious action on salivary digestion when the saliva is not too greatly diluted and the brandy not present in quantities larger than five per cent. With saliva greatly diluted, on the other hand, even one per cent. of brandy is sufficient to cause retardation of amylolytic action. The alcohol of the brandy is in nowise responsible for the inhibitory action.

Experiment 139. (Saliva 1 : 20.)

Fluid added.	Appearance of the achromic point.
0 per cent.	7 minutes.
1 " brandy	12 "
1 " " neutralized	7 "
5 " "	no action beyond erythrodextrin.
5 " " "	16 hours.
2.5 " absolute alcohol	7 minutes.

Experiment 140. (Saliva 1 : 5.)

Fluid added.	Appearance of the achromic point.
0 per cent.	2 minutes.
5 " brandy	12 "
5 " " neutralized	2 "
10 " " "	2 "
5 " absolute alcohol	2 "

[1] With due allowance for such reducing action as the brandy itself possesses.

Evidently, such retarding action as the brandy possesses is mainly connected with the acidity of the fluid, since on neutralization of the liquor its inhibitory action is greatly diminished or even entirely overcome. The following experiment shows that, as with whiskey, the non-volatile matter present in the liquor is not responsible for the retardation of amylolytic action, but has by itself a stimulating effect on amylolysis: —

Experiment 141. (Saliva 1 : 4.)

Brandy residue.	Reduced copper in $\frac{1}{6}$.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.113 gram.[1]	59.4 per cent.	100.0
5 "	0.124 "	65.2 "	109.7
10 "	0.116 "	61.0 "	102.7
15 "	0.104 "	54.7 "	92.0

Rum (with 51 Per Cent. of Alcohol).

Experiment 142. (Saliva 1 : 20.)

Rum.	Appearance of the achromic point.
0 per cent.	11 minutes.
0.5 "	35 "
1.0 "	1.7 hours.
2.0 "	24 "
5.0 "	no action beyond soluble starch.
10.0 "	no action whatever.
Absolute alcohol.	
5.0 per cent.	11 minutes.

Experiment 143. (Saliva 1 : 4.)

Rum.	Reduced copper in $\frac{1}{6}$.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.112 gram.[2]	58.9 per cent.	100.0
5 "	0.057 "	30.0 "	50.8
10 "	0.014 "	7.3 "	12.3
15 "	0.005 "	trace.	

It is to be noticed from these experiments that rum has a far greater retarding action on amylolysis than whiskey or brandy, even when the saliva is fairly concentrated. Further, the alcohol contained in the above percentage of brandy is entirely without influence on amylolytic action. This marked retarding action of rum is due mainly to volatile acid-reacting substances,

[1] With deduction for the reducing action of the sugar present in the brandy.

[2] Making allowance for the reducing action of the rum itself.

presumably of the same nature as those present in whiskey and brandy, but present in larger amount. All samples of rum that we have examined have shown a decided acid reaction, considerably greater than we have found in whiskey or brandy, and to this we attribute the greater retarding action of this liquor. The following experiments attest the proof of this statement: —

Experiment 144. (Saliva 1 : 20.)

Fluid added.			Appearance of the achromic point.
0 per cent.			7 minutes.
1 "	rum		3 hours.
1 "	"	neutralized	7 minutes.
5 "	"		no action beyond erythrodextrin.
5 "	"	"	7 minutes.
2.5 "	absolute alcohol		7 "

Experiment 145. (Saliva 1 : 10.)

Fluid added.			Appearance of the achromic point.
0 per cent.			3 minutes.
5 "	rum		16 hours.
10 "	"		no action beyond erythrodextrin.
10 "	"	neutralized	3 minutes.
5 "	absolute alcohol		3 "

Thus, simple neutralization of the acidity of the rum is all that is needed to overcome wholly the retarding action of this fluid on salivary digestion. Further, the following experiment made with the residue obtained by the evaporation of rum shows that this acidity is due to something volatilized by heat, since no trace of its action is to be found in the residue: —

Experiment 146. (Saliva 1 : 4.)

Rum residue.	Reduced copper in $\frac{1}{6}$.	Maltose formed.	Relative amylolytic action.
0 per cent.	0.119 gram.[1]	62.5 per cent.	100.0
5 "	0.119 "	62.5 "	100.0
10 "	0.119 "	62.5 "	100.0
15 "	0.116 "	60.7 "	97.1

We may summarize our results with these strong alcoholic beverages as follows: Whiskey and brandy used dietetically, say to the extent of five per cent. in a digesting mixture, have no retarding influence upon the salivary digestion of farinaceous foods, providing the saliva is not too greatly diluted. When

[1] Allowance being made for the reducing action of the residue itself.

present in larger quantities they exert a retarding action upon amylolysis which is out of all proportion to the contained alcohol. The inhibitory effect appears to be connected in part, and perhaps mainly, with acid-reacting substances more or less volatile or destructible in nature. Rum differs from the two preceding liquors in that it has a more marked retarding action, — an action dependent chiefly upon the presence in larger quantity of these acid substances, and not connected with the amount of alcohol present.

Action of Wines.

Our study of the influence of wines on the salivary digestion of farinaceous foods shows that these fluids are extremely potent in checking the action of the salivary ferment. Further, this action is entirely unconnected with the alcohol present in the wines, but is dependent almost wholly upon their acid character. Indeed, it is safe to say that as a rule the retarding action of wines on amylolysis is practically proportional to the acidity of the fluid. On neutralization of these acid wines their retarding action on salivary digestion at once disappears, as the following experiments show: —

Sherry (with 21 Per Cent. of Alcohol and 4.7 Per Cent. of Solid Matter).

Experiment 147. (Saliva 1 : 10.)

Sherry.	Appearance of the achromic point.
0 per cent.	2 minutes.
0.5 "	17 hours.
1.0 "	no action beyond erythrodextrin.
2.0 "	no action beyond soluble starch.
5.0 "	no action whatever.
Absolute alcohol.	
1.0 per cent.	2 minutes.

Experiment 148. (Saliva 1 : 5.)

Fluid added.	Appearance of the achromic point.
0 per cent.	1 minute.
1 " sherry	16 hours.
1 " " neutralized	1 minute.
2 " "	no action beyond erythrodextrin.
2 " " "	1 minute.
5 " "	no action whatever.
5 " " "	1 minute.

Claret (with 10 Per Cent. of Alcohol and 3.3 Per Cent. of Solid Matter).

Experiment 149. (Saliva 1 : 15.)

Claret.	Appearance of the achromic point.
0 per cent.	7 minutes.
0.5 "	no action beyond erythrodextrin.
1.0 "	no action whatever.
2.0 "	" "
5.0 "	" "
10.0 "	" "
Absolute alcohol.	
1.0 per cent.	7 minutes.

Experiment 150. (Saliva 1 : 10.)

Claret.	Appearance of the achromic point.
0 per cent.	2 minutes.
0.5 "	erythrodextrin stage.
1.0 "	soluble starch only.
2.0 "	no action whatever.
5.0 "	" "
Absolute alcohol.	
0.5 per cent.	2 minutes.

Experiment 151. (Saliva 1 : 15.)

Fluid added.	Appearance of the achromic point.
0 per cent.	3 minutes.
1 " claret	soluble starch only.
1 " " neutralized	3 minutes.
5 " "	no action whatever.
5 " " "	3 minutes.
0.5 " absolute alcohol	3 "

Experiment 152. (Saliva 1 : 3.)

Fluid added.	Appearance of the achromic point.
0 per cent.	1 minute.
1 " claret	$4\frac{2}{3}$ hours.
2 " "	no action beyond erythrodextrin.
5 " "	no action whatever.
5 " " neutralized	1 minute.

Hochheimer (with 11 Per Cent. of Alcohol and 1.8 Per Cent. of Solid Matter).

Experiment 153. (Saliva 1 : 20.)

Hochheimer.	Appearance of the achromic point.
0 per cent.	8 minutes.
0.5 "	erythrodextrin stage.
1.0 "	soluble starch.
2.0 "	no action whatever.
5.0 "	" "
10.0 "	" "
Absolute alcohol.	
1.0 per cent.	8 minutes.

Experiment 154. (Saliva 1 : 15.)

Hochheimer.	Appearance of the achromic point.
0 per cent.	6 minutes.
0.5 "	erythrodextrin stage.
1.0 "	soluble starch only.
2.0 "	no action whatever.
5.0 "	" "
10.0 "	" "
Absolute alcohol.	
1.0 per cent.	6 minutes.

Experiment 155.

Hochheimer.	Appearance of the achromic point.	
	Saliva 1 : 10.	Saliva 1 : 5.
0 per cent.	3 minutes.	2 minutes.
0.5 "	erythrodextrin and sugar.	16 hours.
1.0 "	no action beyond erythrodextrin.	16 "
2.0 "	soluble starch.	erythrodextrin only
5.0 "	no action whatever.	soluble starch.
Absolute alcohol.		
1.0 per cent.	3 minutes.	2 minutes.

Experiment 156. (Saliva 1 : 15.)

Fluid added.	Appearance of the achromic point.
0 per cent.	5 minutes.
1 " hochheimer	no action beyond erythrodextrin.
1 " " neutralized	4 minutes.
5 " "	no action whatever.
5 " " "	4 minutes.
0.5 " absolute alcohol	5 "

Experiment 157. (Saliva 1 : 3.)

Fluid added.	Appearance of the achromic point.
0 per cent.	1 minute.
1 " hochheimer	27 minutes.
2 " "	erythrodextrin stage.
5 " "	soluble starch with erythrodextrin.
5 " " neutralized	1 minute.

In conclusion we may quote the words of Sir William Roberts,[1] whose views on this subject are in close harmony with our results: "Both the stronger and the lighter wines show a powerful inhibitory effect on salivary digestion. Even so small a proportion as one per cent. of sherry or hock was found to paralyze saliva almost completely, and even one half or one quarter of this proportion delayed the achromic point appre-

[1] *Digestion and Diet*, p. 117.

ciably. Claret and port wine behaved similarly. The inhibitory effect of wines is entirely due to the very considerable degree of acidity which they all possess. . . . When the acidity of wines is neutralized they lose entirely their inhibitory effect on salivary digestion."

Action of Malt Liquors.

Under the head of malt liquors we have experimented with essentially the same beverages as were described under gastric digestion, viz., porter, stout, lager beer, and ale, the same brands likewise being employed.

Porter.

Experiment 158.

Porter.	Appearance of the achromic point. Saliva 1 : 20.	Saliva 1 : 10.
0 per cent.	11 minutes.	3 minutes.
0.5 "	79 "	18 "
1.0 "	22 hours.	74 "
2.0 "	erythrodextrin only.	174 "
5.0 "	soluble starch and erythrodextrin.	25 hours.
10.0 "	soluble starch only.	erythrodextrin only.
Absolute alcohol.		
0.5 per cent.	11 minutes.	3 minutes.

Experiment 159. (Saliva 1 : 10.)

Porter.		Appearance of the achromic point.
0 per cent.		3 minutes.
1 "		23 "
1 "	heated[1]	23 "
2 "		103 "
2 "	"	103 "
Absolute alcohol.		
0.5 per cent.		3 "

Experiment 160.

Porter.		Appearance of the achromic point. Saliva 1 : 10.	Saliva 1 : 15.
0 per cent.		2 minutes.	4 minutes.
1 "		15 "	28 "
1 "	neutralized	1 minute.	3 "
2 "		65 minutes.	225 "
2 "	"	1 minute.	3 "
Absolute alcohol.			
0.5 per cent.		2 minutes.	4 "

[1] Porter which had been previously heated with an inverted condenser in a water-bath for two hours. The carbonic acid is thus driven off, while the alcohol and other volatile matters condense and flow back into the fluid, the volume remaining constant.

Experiment 161. (Saliva 1 : 5.)

Porter.	Appearance of the achromic point.
0 per cent.	1 minute.
2 "	3 minutes.
5 "	31 "
10 "	195 "
10 " neutralized.	1 minute.
Absolute alcohol.	
0.5 per cent.	1 "

From these results the conclusion is plain that porter retards the salivary digestion of farinaceous foods very greatly, but that the inhibition is due entirely to the acidity of the fluid, and not to the contained alcohol. Further, the acidity due to the dissolved carbonic acid is not connected with the inhibitory action, since the fluid freed from carbonic acid by heat produces the same retardation as the original fluid. It is likewise noticeable that porter has far less retarding action on salivary digestion than corresponding percentages of wine, owing presumably to the smaller content of acid-reacting bodies. Again, there is a suggestion in the case of neutralized porter (Experiment 160) of a slight stimulation of amylolytic action, due presumably to the presence of the various extractives.

Lager Beer (New Haven Keg Beer).

Experiment 162. (Saliva 1 : 25.)

Beer.	Appearance of the achromic point.
0 per cent.	15 minutes.
0.5 "	20 "
1.0 "	37 "
2.0 "	45 "
5.0 "	138 "
10.0 "	175 "
Absolute alcohol.	
0.5 per cent.	15 "

Experiment 163. (Saliva 1 : 20.)

Beer.	Appearance of the achromic point.
0 per cent.	9 minutes.
5 "	77 "
10 "	147 "
15 "	147 "
20 "	167 "

Experiment 164. (Saliva 1 : 25.)

Beer.		Appearance of the achromic point.
0 per cent.		18 minutes.
1 "		36 "
1 "	heated[1]	20 "
2 "		54 "
2 "	"	36 "
Absolute alcohol.		
0.5 per cent.		18 "

Experiment 165. (Saliva 1 : 25.)

Beer.		Appearance of the achromic point.
0 per cent.		24 minutes.
1 "		50 "
1 "	heated and neutralized	10 "
2 "		65 "
2 "	" "	10 "
5 "		80 "
5 "	" "	10 "

From these results it is seen that the inhibitory action on salivary digestion of this sample of lager beer is considerably less than that of porter. Further, as in porter, such retardation as the beer causes is due wholly to the acidity of the fluid. Indeed, it is to be noticed that the neutralized beer tends to increase very decidedly the rate of amylolytic action. This is so marked as to suggest the possibility of the beer itself having an amylolytic action, although it can hardly be supposed that any amylolytic ferment present in the beer could resist the destructive action of the heat applied to the fluid before it was neutralized. Careful experiments, however, with the fresh beer failed to show any amylolytic action on the part of the fluid itself ; so that we are forced to the conclusion that the beer possesses a twofold action on amylolysis. The stronger action due to the acidity of the fluid is a retarding one, but when this is overcome by neutralization of the fluid, then the second action asserts itself, viz., a stimulation of salivary digestion due to some of the extractive matters of the beer. The alcohol present in the fluid is practically without action on the solvent power of the saliva on farinaceous foods. Unlike the experiments with porter, simply heating the beer (see Experiment 164) on a water-bath with an inverted condenser, so as to drive

[1] Previously heated in the same manner as the porter in Experiment 159.

off the contained carbonic acid, tends to decrease the retarding action of the beer. This fact is hardly attributable to the loss of carbonic acid, certainly not wholly, and is perhaps due to some more profound change, since it was observed that the fluid tended to change its appearance with formation of a flocculent precipitate, etc.

Milwaukee Lager Beer (Pabst's).

Experiment 166. (Saliva 1 : 25.)

Beer.	Appearance of the achromic point.
0 per cent.	10 minutes.
0.5 "	17 "
1.0 "	30 "
2.0 "	75 "
5.0 "	140 "
10.0 "	160 "
Absolute alcohol.	
0.5 per cent.	10 "

Experiment 167. (Saliva 1 : 25.)

Beer.	Appearance of the achromic point.
0 per cent.	10 minutes.
1.0 "	35 "
1.0 " heated [1]	14 "
2.0 "	75 "
2.0 " "	35 "
Absolute alcohol.	
0.5 per cent.	10 "

Experiment 168. (Saliva 1 : 25.)

Beer.	Appearance of the achromic point.
0 per cent.	15 minutes.
1 "	22 "
1 " heated and neutralized	10 "
2 "	50 "
2 " " "	10 "
5 "	60 "
5 " " "	10 "

Experiment 169.

Beer.	Appearance of the achromic point.	
	Saliva 1 : 25.	Saliva 1 : 15.
0 per cent.	15 minutes.	12 minutes.
30 "	180 "	105 "

[1] Previously heated in the same manner as the porter and beer in the preceding experiments.

The above results are practically confirmatory of the results obtained with New Haven beer, and we may derive from them the same conclusions as have already been drawn in connection with the preceding sample.

Ale (Bass & Co.'s Pale Ale).

Experiment 170.

Ale.	Appearance of the achromic point.		
	Saliva 1 : 20.	Saliva 1 : 15.	Saliva 1 : 10.
0 per cent.	9 minutes.	5 minutes.	2 minutes.
0.5 "	19 "	7 "	3 "
1.0 "	43 "	25 "	4 "
2.0 "	200 "	75 "	7 "
5.0 "	260 "	195 "	46 "
10.0 "	320 "	255 "	64 "
Absolute alcohol.			
0.5 per cent.	9 "	—	—

Experiment 171. (Saliva 1 : 15.)

Ale.	Appearance of the achromic point.
0 per cent.	6 minutes.
1 "	16 "
1 " heated[1]	14 "
2 "	54 "
2 " "	45 "
Absolute alcohol.	
0.5 per cent.	6 "

Experiment 172.

Ale.	Appearance of the achromic point.	
	Saliva 1 : 15.	Saliva 1 : 20.
0 per cent.	5 minutes.	6 minutes.
1 "	19 "	35 "
1 " heated and neutralized	3 "	3 "
2 "	92 "	140 "
2 " " "	3 "	3 "
5 "	177 "	245 "
5 " " "	3 "	3 "

Experiment 173.

Ale.	Appearance of the achromic point.	
	Saliva 1 : 15.	Saliva 1 : 10.
0 per cent.	5 minutes.	3 minutes.
30 "	295 "	115 "

[1] Ale which had been previously heated in a water-bath with inverted condenser, more especially for the removal of the carbonic acid.

Stout (Guiness's Extra Stout, Dublin).

Experiment 174.

Stout.	Appearance of the achromic point. Saliva 1 : 15.	Saliva 1 : 10.	Saliva 1 : 5.
0 per cent.	4 minutes.	4 minutes.	3 minutes.
0.5 "	$10\frac{1}{4}$ hours.	14 "	—
1.0 "	22 "	$4\frac{1}{4}$ hours.	5 minutes.
2.0 "	erythrodextrin.	erythrodextrin.	20 "
5.0 "	erythrodextrin and soluble starch.	erythrodextrin and soluble starch.	$6\frac{1}{4}$ hours.
10.0 "	soluble starch only.	soluble starch only.	24 "
Absolute alcohol.			
0.5 per cent.	4 minutes.	—	—
1.0 "	—	—	3 minutes.

Experiment 175. (Saliva 1 : 10.)

Stout.		Appearance of the achromic point.
0 per cent.		3 minutes.
1 "		300 "
1 "	heated	161 "
2 "		20 hours.
2 "	"	20 "
Absolute alcohol.		
0.5 per cent.		3 minutes.

Experiment 176. (Saliva 1 : 10.)

Stout.		Appearance of the achromic point.
0 per cent.		2 minutes.
1 "		83 "
1 "	heated and neutralized	2 "
2 "		415 "
2 "	" "	2 "
Absolute alcohol.		
0.5 per cent.		2 "

Experiment 177. (Saliva 1 : 5.)

Stout.		Appearance of the achromic point.
0 per cent.		2 minutes.
10 "		24 hours.
10 "	heated and neutralized	2 minutes.
Absolute alcohol.		
1.0 per cent.		2 "

Stout differs from the other malt liquors examined only in that its retarding action on salivary digestion is a trifle more pronounced, due. we think, solely to its somewhat greater acidity. Acidity is the keynote to the cause of the retarding action of malt liquors in general on salivary digestion. Remove

the acidity of the fluid and we remove the disturbing factor; indeed, the neutralized malt liquors even stimulate digestion in some instances.

Thus, we find beer and ale more favorable to salivary digestion than porter and stout, simply because the former, as a rule, contain less acid than the latter. In our experiments we found stout to have an acidity two and even three times that of ordinary lager beer, and twice that of ale, while porter had an acidity somewhat less than that of stout, but twice that of beer and ale.

For example, samples of the above malt liquors showed the following relative acidity, expressed by the number of cubic centimetres of a 0.2 per cent. solution of KOH required to neutralize 25 c. c. of the respective fluids: —

25 c. c. stout required	46.0 c. c. alkali solution.		
25 " porter "	34.0 "	"	"
25 " ale "	19.0 "	"	"
25 " beer "	10–17 "	"	"

Sir William Roberts, who has also made a study of this matter, says: "Malt liquors were found to hamper salivary digestion exactly in proportion to their degree of acidity. Sound English beers have not nearly so much acidity as wines, and they interfere comparatively little with the digestion of starch; but 'turned' beer is highly inhibitory."

In concluding this chapter of our work we may again emphasize the following facts: Alcohol, even when present in considerable quantities, has no marked effect upon the amylolytic or starch-digesting power of the saliva. Alcoholic beverages, however, do have a retarding action upon amylolysis, the extent of retardation varying with the strength of the saliva. Obviously, the retardation cannot be attributed to the alcohol present. Our results, indeed, show that the detrimental factor is, in most cases, the acidity of the fluid; for after neutralization of the alcoholic liquid no marked embarrassment of amylolytic action is to be observed. Occasionally, as with whiskey, neutralization of the fluid is not followed by a complete withdrawal of inhibitory action; hence in this case we are forced to attribute the retarding action of this liquor in part to the presence of some ethereal compounds, such as are frequently

found in small quantity in the stronger alcoholic liquors. Wines, in virtue of their greater acidity, have a far more pronounced retarding action upon salivary digestion than the stronger alcoholic fluids, and, as might be expected, the extent of retardation caused by a given wine is dependent solely upon its degree of acidity. Wines which have been neutralized are practically without influence upon salivary digestion.

Malt liquors, likewise, owe such retarding action as they possess mainly, if not wholly, to the presence of acid or of acid-reacting bodies. Consequently, we may conclude that the retardation of salivary digestion caused by ordinary alcoholic drinks is in character similar to the retardation which follows the use of vinegar, lemon juice, or other acid fluids, or mixtures such as salads highly seasoned with vinegar, etc., the only difference being that the latter class are unquestionably more vigorous in their retarding action from their greater degree of acidity. We may, indeed, query whether under normal circumstances in the body the retarding action of all these fluids, alcoholic or otherwise, is quite as great as our experiments would at first glance indicate. It must not be overlooked that the saliva is ordinarily alkaline, the degree of alkalinity in some cases, at least, being equal to 0.08 per cent. of sodium carbonate. With such an alkaline fluid, aided perhaps by alkaline food, a portion at least of the disturbing acid of the alcoholic beverage, especially if the latter is not imbibed in too large quantity, may be neutralized and thus deterred from exercising any deleterious influence. Further, the widespread use of effervescent table waters, such as Apollinaris water and others charged with alkaline carbonates, as additions to wines of the claret and hock type, would likewise lead to a diminution of the danger in this direction. On the other hand, the acid alcoholic beverages, especially the sour wines and other liquors with pronounced acid reaction, must always be a menace to the thorough and vigorous digestion of farinaceous foods both by the saliva and pancreatic juice, provided the latter is exposed to their influence. This, obviously, may be a matter of little moment to a vigorous person with abundant digestive resources, but to the weak and ailing individual with scant digestive powers it may be a matter of vital importance.

D. SUMMARY.

The following summary, in which will be found many repetitions of previous statements, will suffice to make clear the general tenor of our results: —

Pure ethyl alcohol, the active agent in all so-called alcoholic liquors, when present in small amount — say one or two per cent. of absolute alcohol, equal approximately to two to four per cent. of proof spirit — has little or no action upon the digestive power of the gastric juice. There is, indeed, a slight tendency for such amounts of alcohol to increase somewhat the proteolytic power of the enzyme; in other words, the digestive power on proteid foods may be slightly increased. As the percentage of alcohol is raised, retardation or inhibition of proteolytic action becomes pronounced, although not very marked until the digesting mixture contains five to ten per cent. or more of absolute alcohol. With fifteen to eighteen per cent. of absolute alcohol, digestive action may be reduced one quarter or even one third. Especially important is the fact that the extent of retardation by a given percentage of alcohol varies greatly with the strength or activity of the gastric juice and with the digestibility of the proteid material. Everything else being equal, the greater the strength or digestive power of the gastric juice the less is the retardation, while, on the other hand, the weaker the gastric juice the greater the inhibitory action of a given amount of absolute alcohol. It is, therefore, impossible to make a general specific statement regarding the action of given percentages of alcohol under all conditions. Our results agree essentially with those obtained by Sir William Roberts, who found that in the presence of less than ten per cent. of proof spirit (five per cent. of absolute alcohol) there was no appreciable retardation of gastric digestion. With ten per cent. of proof spirit retardation was only barely detectable, while with twenty per cent. retardation was quite distinct. Beyond this point the inhibitory effect of alcohol increased rapidly.

On the proteolytic action of the pancreatic juice absolute alcohol exercises a more marked influence, the presence of even two or three per cent. being sufficient to produce a distinct retardation of digestive action. Still, as in the case with gas-

tric digestion, the exact amount of retardation is greatly dependent upon the digestive power of the pancreatic fluid. When the amount of absolute alcohol present in the digesting mixture is less than one per cent., the inhibition of proteolytic action is very slight, provided the ferment is fairly vigorous in its action.

On the digestion of farinaceous foods by the saliva absolute alcohol has no very marked influence. With active saliva not greatly diluted the presence of even five per cent. of absolute alcohol may lead to a slight increase in digestive power. Larger quantities of alcohol cause retardation of amylolytic action, but even ten per cent. of absolute alcohol causes only a slight retardation. As this percentage of absolute alcohol is equal to at least twenty per cent. of proof spirit, it follows that pure alcohol, free from admixture, is not liable to interfere materially with the digestion of starchy foods by the saliva nor presumably by the pancreatic juice.

Strong alcoholic beverages, such as whiskey, brandy, rum, and gin, containing ordinarily about fifty per cent. of absolute alcohol, and with only a small amount of solid or extractive matter, have an action upon gastric digestion practically proportional to the quantity of alcohol present. Thus, with a vigorous gastric juice the presence of even ten per cent. of whiskey results simply in a slight retardation of digestive action. The same is true of brandy, gin, and rum. With a weak gastric juice the retarding action is much greater. When digestive action is fairly vigorous the presence of small percentages of whiskey causes practically no retardation ; indeed, there is even a slight suggestion of increased digestive action in the presence of three per cent. of whiskey, much the same as was observed in the experiments with absolute alcohol. In the presence of twenty per cent. of whiskey, on the other hand, digestive activity may be reduced one fourth, and when the gastric juice is very weak from scarcity of the active ferment, then even small amounts of whiskey may exercise a very marked retarding effect upon the digestive process. Such retardation of gastric digestion as whiskey, brandy, gin, and rum produce is connected mainly with the presence of alcohol or other volatile matter contained in the liquor, the solid matter present in the fluid not showing, as a rule, any evidence of responsibility for the inhibitory action. The conclusion is obvious that pure whiskey,

brandy, rum, and gin are no more deleterious to gastric digestion than corresponding strengths of absolute alcohol, and, further, that in the healthy individual these liquors can be considered to impede the gastric digestion of proteid foods only when taken immoderately and in intoxicating doses.

With reference to the composition of whiskey as bearing upon possible variations in the action of this fluid on gastric digestion, our results show merely a variation in the percentage of alcohol present, suggestive of more or less addition of water. The few results obtained by us in this direction show variations in the percentage of alcohol ranging from thirty to fifty per cent. There was likewise some variation in the quantity of tannin present, but in no case was the amount of the latter large.

As to so-called fusel oils, our results show that the higher alcohols, supposedly contained in such oils in small quantities, tend to increase rather than decrease the proteolytic action of the gastric juice. Thus, methyl, propyl, isobutyl, and amyl alcohols all increase somewhat the digestive power of the gastric juice when present in small amount. Large quantities have a decided inhibitory action. Plainly, however, if these alcohols are common impurities in whiskeys, brandies, and related liquors, they do not exercise any deleterious influence upon the proteolytic action of the gastric juice.

On pancreatic digestion whiskey is quite active. The sensitiveness of the pancreatic ferment to this form of alcoholic liquor is quite marked. Further, the retarding action of a given percentage of whiskey is greater than that of a corresponding percentage of pure alcohol, thus indicating the presence of an additional inhibitory substance which is apparently a part of the solid matter of the whiskey and is undoubtedly connected with the acidity of the fluid. Brandy and rum have essentially the same action upon pancreatic digestion as whiskey. Both retard proteolysis quite noticeably, and with both fluids the retardation is somewhat greater than that caused by a corresponding strength of alcohol.

The higher alcohols, such as are present in fusel oils, have a somewhat greater inhibitory action upon pancreatic digestion, i. e., trypsin-proteolysis, than ethyl alcohol; but when it is remembered that these alcohols can be present in whiskey, brandy, etc., only in very small quantities, it is seen that they can exer-

cise very little influence in modifying the action of alcoholic liquors upon pancreatic proteolysis.

On the digestion of farinaceous foods by the saliva, whiskey and brandy have no retarding influence when present to the extent of five per cent., provided the saliva is not too greatly diluted. Present in larger quantities, or when mixed with weak or greatly diluted saliva, they exert a retarding influence upon amylolytic action which is out of all proportion to the contained alcohol. The inhibitory action is connected mainly with the acidity of the alcoholic fluid, for on neutralization of this acidity the inhibitory action of the liquor ceases. Rum differs from whiskey and brandy in having a somewhat greater inhibitory action, due simply to the greater acidity of this fluid, and is nowise connected with the alcohol present.

The heavier alcohols, viz., amyl, butyl, propyl, etc., all tend to increase the amylolytic action of the saliva when present in small quantity.

Wines, as a class, when present in small amount, have little or no deleterious action upon the chemical processes of gastric digestion. In small amount they may even increase somewhat the rate of digestive action. In larger quantities they have more or less of a retarding effect, which is dependent more upon the character and amount of the solid matter present than upon the contained alcohol. Thus, with wines containing ten per cent. of alcohol the alcohol is of minor importance so far as the influence of the fluid upon the solvent or digestive power of the gastric juice is concerned.

On pancreatic digestion wines have a far greater inhibitory action than the stronger alcoholic liquors. This action, under ordinary circumstances, is almost entirely independent of the content of alcohol and is very closely connected with the acidity of the fluid. Thus, a strongly acid wine, like a claret with only ten per cent. of alcohol, has a far greater retarding action on trypsin-proteolysis than a sherry with twice that content of alcohol but with less acidity.

On salivary digestion wines as a class show a very powerful inhibitory effect, an effect which is due almost entirely to their acid properties. Thus, when the acidity of a wine is neutralized it loses completely its inhibitory effect on salivary digestion.

Malt liquors in small quantities are without any marked in-

fluence on the digestive power of the gastric juice. In larger quantities they cause an inhibition of proteolysis which is entirely unconnected with the small amounts of alcohol present, but directly traceable to the comparatively large amounts of extractives they contain.

On pancreatic digestion the malt liquors as a class exert an inhibitory effect which, however, is not very pronounced. The retarding action is due mainly to the character of the solid or extractive matters present in the liquors and is practically unconnected with the content of alcohol. The inhibitory action of malt liquors is far less pronounced than that of wines.

On salivary digestion malt liquors have a very great retarding effect, especially when the saliva is quite dilute. With saliva less diluted the retarding action is far less pronounced. The inhibitory action of these liquors is due solely to their acidity. Remove the acidity by neutralization with an alkali and the inhibitory action disappears.

Finally, it is to be plainly understood that these conclusions apply solely to the influence of the various liquors studied upon the purely chemical processes of digestion — i. e., upon amylolysis and proteolysis. The results recorded do not afford data for drawing any broad or general conclusions regarding the influence of alcoholic drinks upon digestion or alimentation, since they throw no light upon possible modifications of secretion, absorption, or peristalsis. We have now positive data regarding the action of alcohol and various alcoholic fluids upon the digestive action or solvent power of the saliva, gastric juice, and pancreatic juice, the three important digestive fluids of the body; but before we can answer the question, How do alcoholic fluids affect digestion? we must ascertain the influence of these fluids upon the secretion of the digestive juices and upon the absorption of the products of digestion, as well as upon peristalsis, and not until these points have been thoroughly studied shall we be able to understand fully the action of these beverages upon the whole process of digestion.

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2. The Influence of Alcohol and Alcoholic Drinks upon Digestion, with Special Reference to Secretion.[1]

In the preceding section it was carefully pointed out that any complete and satisfactory answer to the question, "How do alcoholic fluids affect digestion?" cannot be obtained by any single line of experimentation, since the rate and extent of

[1] The experiments here reported were originally published by R. H. Chittenden, Lafayette B. Mendel, and Holmes C. Jackson in the *American Journal of Physiology*, vol. i. 1898.

digestion may be modified in a variety of ways and through a variety of channels. Thus, due consideration must be given not only to the direct influence of alcoholic fluids upon the solvent or digestive power of the several digestive juices, but heed must also be given to the qualitative and quantitative modifications which the secretions themselves may undergo, as well as to variations in the rate of absorption and to the possible interaction of these and other factors. The data already presented throw light upon the extent to which alcoholic fluids affect the purely chemical processes of digestion. In the continuation of these studies our efforts have been directed mainly to acquiring a fuller knowledge of the action of alcoholic beverages upon secretion; and in so doing new data have been obtained which, it is hoped, will prove of value in explaining more fully the action of these fluids upon the whole process of digestion.

A. SALIVARY SECRETION.

The current statements regarding the influence of alcohol on the secretion of saliva are confined to a brief reference to the direct action on the flow into the mouth. Thus, it is stated that almost coincident with the burning sensation caused by alcohol taken into the mouth a copious flow of saliva begins, due to reflex stimulation of the glands through the nervous system.[1] We have performed experiments with the object of ascertaining (1) the possible variations in the amount of salivary flow due to the presence of alcoholic fluids in the mouth, psychical influences being eliminated as far as possible; (2) the character of the saliva thus secreted; (3) the influence upon secretion of alcoholic beverages introduced into the stomach. It seemed particularly desirable to investigate this latter phase in view of the asserted influence of irritating substances (vinegar, alcoholic extract of pepper, etc.) when introduced directly into the alimentary tract through a fistula. There is said to result under such conditions a reflex flow of saliva, the nervous impulses being transmitted through the vagus.[2]

[1] Compare, for example, Kühne, *Lehrbuch der Physiol. Chemie*, 1868, p. 2; Lauder Brunton, *Disorders of Digestion*, 1886, p. 143.

[2] Oehl: *Comptes rendus*, lix. p. 336, quoted by Heidenhain, Hermann's *Handbuch der Physiologie*, 1883, v. p. 83.

The Influence of Alcoholic Fluids introduced into the Mouth.

In the following experiments the attempt was made to ascertain something as to the character and extent of the direct stimulation of the salivary glands provoked by the presence of alcoholic fluids in the mouth, as well as to determine what quantitative changes, if any, may be called forth in the composition of the secretion in this way. These experiments were made on both man and dogs. The method, in the first instance, consisted in taking into the mouth 10 c. c. of the fluid studied and allowing it to remain there for an instant previous to swallowing it. The normal conditions were thus closely imitated and reflex influences from the stomach not excluded. The head was now turned to one side and rested upon the arm, the saliva being allowed to collect in the cavity of the mouth. As the fluid accumulated it was from time to time, during fifteen to twenty minutes, allowed to flow out of a corner of the mouth into a measuring vessel. Movements of the jaws and tongue were carefully avoided and psychic stimulation was excluded as far as possible. The method, already recommended by Hofbauer,[1] was found to be reasonably satisfactory, and control trials showed that the quantities of saliva obtained within periods of fifteen or twenty minutes could be appropriately compared.

Of the saliva thus collected 3–4 c. c. were taken for analysis. A weighed quantity was dried in a tared crucible on a water-bath and then for four or five hours at 105° C., this time being found sufficient to bring crucible and contents to a constant weight. Total solids were thus determined. The crucible was then ignited, care being taken to prevent loss by volatilization of salts. The ash thus obtained is given as salts in the protocols, while the organic constituents were obtained by subtracting the amount of salts from the total solids. In some cases the amount of chlorine in the ash was determined by the usual method of titration with weak silver nitrate solution. The analytical results are all expressed in percentages. The following figures serve to illustrate the results of a typical duplicate analysis: —

[1] Hofbauer, *Archiv für die ges. Physiol.*, 1897, lxv. p. 503.

Submaxillary Saliva of Dog.

	Water.	Total solids.	Organic constituents.	Salts.	Chlorine.
A.	98.99	1.01	0.80	0.21	0.042
B.	98.99	1.01	0.78	0.23	0.040

It is an observation easily verified, that the presence of a small quantity of strong alcohol or alcoholic beverage in the mouth excites a sudden flow of saliva. This acceleration in flow is, at most, a very brief one, and the rate of flow quickly returns to that pertaining to normal conditions, i. e., absence of stimuli in the mouth. The stimulation in this case is not due merely to the mechanical action of the fluid introduced, nor is it a form of stimulation specific for alcohol alone, as our experiments on dogs have demonstrated. Thus, animals were anæsthetized with ether and chloroform through a tracheal cannula (thereby avoiding direct stimulation of salivary flow), a small dose of morphine, or a larger one of chloral, having been previously administered. A cannula was then introduced into one or both ducts of the submaxillary glands. A small wad of absorbent cotton moistened with the fluid to be studied was introduced with a forceps into the back of the mouth upon the tongue and the flow of saliva from the ends of the cannulas noted. It was found by this method that water or weak sodium chloride solution (0.7 per cent.) produced no further effect than the secretion of a drop or two of saliva, due to the mere mechanical action of introducing the wad; with increasing strengths of salt the secretion was decidedly accelerated, flowing readily after application of twenty per cent. salt solution, the acceleration, however, being very brief in duration (five minutes). The buccal cavity could be swabbed out with water occasionally, the effect being a minimal one. It was found that *weak* alcohol, introduced in this way, provoked little, if any, flow: while stronger alcohol (fifty per cent.) gave rise to a transitory secretion, the stimulation in this case, however, being far more marked than can be produced by the indirect action of alcohol through the stomach. Thus, in one animal, in which the activity of the glands was found pronounced when a drop of dilute acetic acid was applied to the tongue, injection of 100 c. c. fifty per cent.

Salivary Experiments on Man.

	I.		II.		III.		IV.		V.		VI.		VII.		VIII.	
	water *a*	water *b*	water *a*	water *b*	water *a*	brandy *b*	water *a*	brandy *b*	water *a*	brandy *b*	water *a*	brandy *b*	water *a*	gin *b*	water *a*	sherry *b*
Amount collected in c. c., per 10 minutes.	4.0	4.0	4.4	3.7	2.7	5.3	3.8	4.4	4.7	8.0	4.4	7.1	4.0	4.6	3.5	4.1
Water, per cent.	99.49	99.57	99.52	99.54	99.51	99.49	99.50	99.40	99.57	99.19	99.56	99.45	99.57	99.51	99.41	99.39
Total solids, per cent.	0.51	0.43	0.48	0.46	0.49	0.51	0.50	0.60	0.43	0.81	0.44	0.55	0.43	0.49	0.59	0.61
Organic constituents, per cent.	0.36	0.31	0.35	0.33	0.33	0.35	0.35	0.45	0.31	0.58	0.30	0.38	0.31	0.35	0.41	0.43
Salts, per cent.	0.15	0.12	0.13	0.13	0.16	0.16	0.15	0.15	0.12	0.23	0.14	0.17	0.12	0.14	0.18	0.18
Salts calculated on total solids, per cent.	29.0	29.0	28.0	28.0	32.0	32.0	30.0	25.0	29.0	28.0	31.0	31.0	28.0	28.0	30.0	29.0

alcohol directly into the stomach failed to provoke any reflex salivary flow in half an hour.

Turning now to the influence of alcoholic fluids upon the rate of flow and composition of the saliva in man, the accompanying experiments, by the method above indicated, may be cited (page 257). The first two (I and II) show the results obtained with successive portions of water; in the following ones a control experiment with water in each instance preceded the trial with the alcoholic fluid.

The alcoholic content of the fluids employed was as follows: brandy, forty-seven per cent. by volume; gin, fifty-one per cent.; sherry, twenty-one per cent.

From these figures it is seen that the results obtained with two successive portions of water scarcely differ from each other, the tendency, however, being towards decreased flow accompanied by decrease in dissolved material in the saliva. Interpreted in physiological terms, these results indicate that the second stimulation with water is, if anything, weaker than its predecessor. In decided contrast appear the results obtained with the alcoholic liquors. Here may be observed an increased flow of saliva, not pronounced, but accompanied by an increase in both organic and inorganic constituents. The effect is precisely analogous, both in composition and rate of flow, to that brought about by an increase in intensity of stimulation when the salivary glands are electrically excited through their nerves.[1]

The following diagram represents in graphic form the results given in the preceding table, i. e., (1) the relative rate of flow induced by water and by the alcoholic fluid: (2) the content of solid matter, together with the relative proportion of ash or inorganic matter and of organic matter as indicated by the loss on ignition.

[1] Cf. Heidenhain, *Archiv für die ges. Physiol.*, 1878, xvii. 7, and Hermann's *Handbuch der Physiologie*, v. 52.

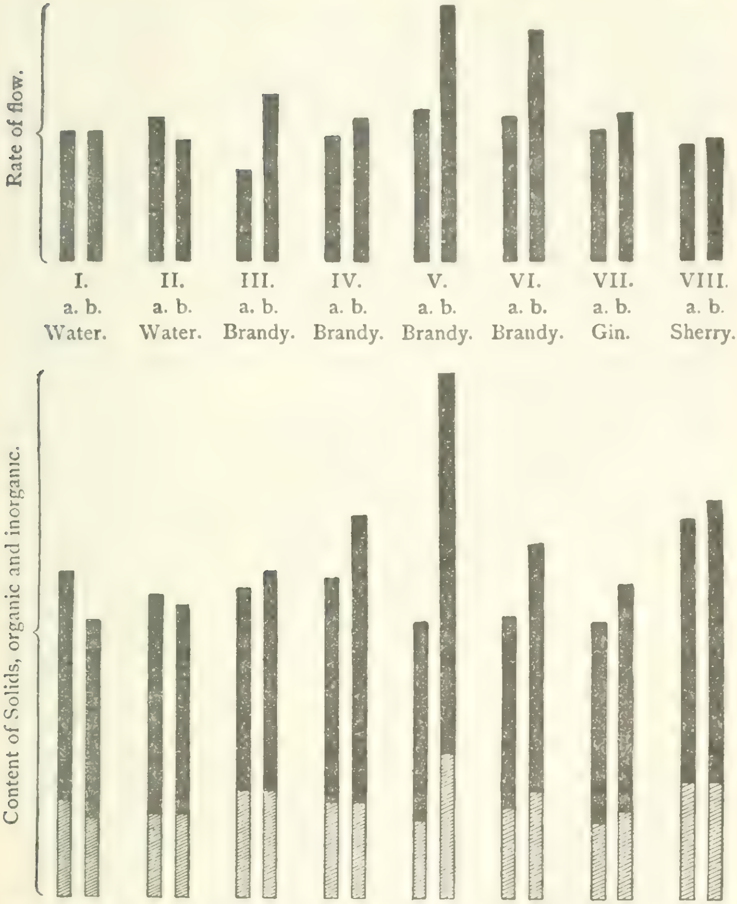


Diagram illustrating the relative influence of alcoholic fluids on the rate of secretion and composition of human saliva.

The Influence of Alcoholic Liquors introduced directly into the Stomach.

In our experiments on the reflex stimulation of salivary flow, the attempt to produce a persistent secretion due to the presence of alcohol in the stomach was unsuccessful: nor have we been able to obtain evidence of an unusual flow of saliva under such circumstances in dogs with gastric fistulæ. It seemed desirable, however, to examine the possible direct influence of

alcoholic fluids on the salivary glands and the resulting secretion, when other factors were excluded as far as possible. In these experiments dogs from ten to eighteen kilos were used. Chloroform-ether mixture was employed to produce anæsthesia and was administered through a tracheal tube in part of the experiments, the danger of respiratory difficulties resulting from salivary flow induced in the glands as a result of the ether stimulation being thus avoided. In the later stages of the experiments the alcohol introduced usually sufficed to maintain the animal in perfect quiet. Fredericq[1] has recommended the use of alcohol for producing narcosis in rabbits; it has been found quite satisfactory for this purpose in the dog, the effects passing off with relative rapidity.

A glass cannula, bent at the end, was tied in Wharton's duct (and occasionally a second cannula into the duct of the sublingual gland). The chordo-lingual nerve was ligatured and cut at some distance centrally to the point where the chorda tympani branches off to the glands. All secretion in the corresponding gland was thus stopped, except during stimulation of the chorda, which was accomplished through raising the peripheral end of the cut nerve by the ligature and slipping hook electrodes under it. The interrupted current of a du Bois induction coil with a single element was used as the stimulus. Saliva was collected in small graduated cylinders. Alcohol was introduced into the stomach by making an incision through the linea alba, etc., and the fluid was injected directly into the organ thus exposed by means of a large needle-pointed syringe. By careful avoidance of the larger gastric vessels, bleeding was minimal. The general course of the experiments was as follows: A distance between the primary and secondary coil of the inductorium was selected, such as a preliminary trial showed to give a medium rate of flow. This stimulus was, so far as possible, kept constant throughout the experiment. The chorda was repeatedly stimulated for periods of one minute, followed by pauses of two minutes, during which the nerve was kept covered. In this way sufficient quantities of saliva for analysis were collected. Before collecting a sample of saliva under any given conditions, the six or seven drops first discharged were thrown away, and thus the fluid stored up from previous stimu-

[1] Fredericq, *Manipulations de physiologie*, p. 19.

lation in the gland lumina, ducts, and cannula was avoided.[1] After collecting two or three control samples, the fluid to be considered (usually warmed slightly) was injected into the stomach in the manner already described, and this was followed by a pause of five minutes. The pulse was observed at frequent intervals to detect any possible influence on the heart's action and consequent blood flow. The samples of saliva collected were analyzed in the manner already described. At the conclusion of the experiment the animal was killed by bleeding, and the condition of the glands, as well as of the stomach and other organs, examined. The protocols of three typical experiments are given below: —

1, iii. 1897. Dog. Weight 14 kilos. Chloroform and ether administered through tracheal tube during part of the experiment. Distance of secondary coil = 200 mm. Period of stimulation = 1 min., followed by a pause of 2 min.

	Time.	Amount saliva collected. c. c.	Rate of secretion per min. c. c.	Water. per cent.	Total solids. per cent.	Organic matter. per cent.	Salts. per cent.	Chlorine. per cent.
I[2]	10.35	5.3	0.7	98.76	1.24	0.94	0.30	0.026
II	11.08	5.4	0.6	98.94	1.06	0.73	0.33	0.036
III	11.38	5.2	0.8	98.95	1.05	0.69	0.36	0.044
IV	11.56	4.0	0.8	98.90	1.10	–	–	0.048
	12.20	80 c. c. 50 per cent. alcohol injected into stomach.						
V	12.35	4.8	0.8	98.96	1.04	0.69	0.35	0.047
VI	12.55	4.8	0.8	99.01	0.99	0.59	0.40	0.076
	1.15	100 c. c. 50 per cent. alcohol injected into stomach.						
VII	1.21	4.9	0.8	99.05	0.95	0.59	0.36	0.055
VIII	1.42	6.0	1.0	99.05	0.95	0.60	0.35	0.060
IX	2.02	5.5	0.9	99.14	0.86	0.52	0.34	0.048
X	2.24	5.2	0.8	99.17	0.83	0.47	0.36	0.042
	2.53	100 c. c. 50 per cent. alcohol injected into stomach.						
XI	2.58	4.5	0.6	99.07	0.93	0.63	0.30	0.034
XII	3.27	6.0	0.6	99.18	0.82	0.53	0.29	0.037
XIII	4.10	5.0	0.7	90.17	0.83	0.49	0.34	0.038

Dog killed. Stomach mucosa normal in appearance. Urinary bladder and gall bladder greatly distended. Stomach contents = 450 c. c., faintly acid in reaction and containing 24.6 grams of alcohol. No food present.

[1] Cf. Heidenhain, Hermann's *Handbuch der Physiologie*, v. 53; Langley and Fletcher, *Philosophical Transactions*, 1889, clxxx. B. 112.

[2] In this first period the distance of the secondary coil was 280 mm., but the stimulation was unsatisfactory.

22, iii. 1897. Bitch. Weight 10 kilos. Chloroform and ether administered during operation. Tracheotomy performed after operation. Distance of secondary coil = 240 mm. Period of stimulation = 1 min., followed by 2 min. pause.

	Time.	Amount saliva collected. c. c.	Rate of secretion per min. c. c.	Water. per cent.	Total solids. per cent.	Organic matter. per cent.	Salts. per cent.	Chlorine. per cent.
I	11.30	4.6	1.1	98.68	1.32	0.03	0.29	0.032
II	11.42	4.7	0.9	98.70	1.30	0.96	0.34	0.074
III	11.57	4.0	0.7	98.84	1.16	0.73	0.43	0.146
	12.35	150 c. c. burgundy injected into stomach.						
IV	12.41	4.9	0.8	98.72	1.28	0.91	0.37	0.092
V	12.59	5.5	0.6	98.78	1.22	0.87	0.35	0.096
VI	1.29	4.7	0.7	98.91	1.09	0.82	0.27	0.071
	2.00	200 c. c. burgundy injected into stomach.						
VII	2.06	4.7	0.6	98.88	1.12	0.82	0.30	0.058
VIII	2.32	–	–	98.98	1.02	0.69	0.33	0.099

Dog killed ; stomach contents = 190 c. c. ; claret color ; mucosa not inflamed. Contents contained 13.1 grams of alcohol. The burgundy used contained 5.2 per cent of alcohol.

12, iv. 1897. Bitch. Weight 9 kilos. Chloroform and ether during operation. Distance of secondary coil = 190 mm. Stimulation, 1 min., followed by a pause of 2 min.

	Time.	Amount saliva collected. c. c.	Rate of secretion per min. c. c	Water. per cent.	Total solids. per cent.	Organic matter. per cent.	Salts. per cent.	Chlorine. per cent.
I	9.24	4.5	0.9	98.76	1.24	0.97	0.27	0.062
II	9.40	4.6	0.7	98.89	1.11	0.81	0.30	0.054
	10.40	100 c. c. distilled water injected into stomach.						
III	10.53	4.7	0.6	99.04	0.96	0.66	0.30	0.049
IV	11.21	5.0	0.5	99.09	0.91	0.60	0.31	0.060
	11.50	100 c. c. distilled water injected into stomach.						
V	11.56	4.5	0.5	99.30	0.70	0.54	0.16	0.024
VI	12.25	4.5	0.6	99.33	0.67	0.36	0.31	0.078
VII	12.51	4.6	0.7	99.39	0.61	0.36	0.25	0.063
	1.18	100 c. c. 50 per cent. alcohol injected into stomach.						
VIII	1.23	5.7	0.7	99.35	0.65	0.36	0.29	0.067
IX	1.44	4.8	0.8	99.38	0.62	0.32	0.30	0.087
X	2.03	4.7	0.7	99.47	0.53	0.29	0.24	0.087
XI	2.25	4.7	0.6	99.47	0.53	0.22	0.31	0.097

Dog killed. Stomach mucosa normal. Contents = 100 c. c. No odor of alcohol.

Experiments of the character indicated by these protocols were carried out with alcohol in varying doses, whiskey, brandy, and wine, and control experiments with water were also made. In attempting to interpret the analytical data thus obtained in experiments extending over several hours, it is necessary to bear in mind facts regarding salivary secretion which seem to be sufficiently established. Ludwig[1] showed that the submaxillary saliva secreted during stimulation of the chorda tympani undergoes a change in composition varying with the duration of the flow, the content of organic solids decreasing in far greater degree than the dissolved salts. Heidenhain[2] found that the percentage of salts in the saliva varies directly with the rate of secretion, quite independently of the state of the gland, the organic constituents, however, being influenced by the condition of the secreting organ as well as by the strength of stimulus and resulting rate of secretion. These observations, verified by Werther[3] and by Langley and Fletcher,[4] have been extended by the latter investigators, who formulated the opinion that "the secretion of organic substances depends wholly, or almost wholly, upon the strength of the stimulus, whilst the secretion of water and of salts depends also upon the amount of blood flowing through the gland."[5] In view of the well-known fact that changes in the strength of the stimulus immediately bring about a change in both rate of secretion and composition of the saliva, we have attempted to maintain a constant stimulus throughout each series of observations by selecting some satisfactory distance of the secondary coil of the inductorium and by applying the electrodes as uniformly as possible. Owing to the gradual decline in the irritability of the exposed nerve, the impossibility of applying the electrodes constantly in one position, and other unavoidable difficulties, ideal results cannot be obtained. However, the difficulties were present in every experiment and the results are therefore more or less comparable.

An examination of the data obtained in the manner above

[1] Ludwig and Becher, *Zeitschr. f. rat. Med.*, 1851, N. F., i. 278. Cf. also Heidenhain, Hermann's *Handbuch der Physiologie*, v. 47–49.

[2] Heidenhain, *Archiv für die ges. Physiol.*, 1878, xvii. pp. 4, 6.

[3] Werther, *Archiv. f. d. ges. Physiol.*, 1886, xxxviii. p. 293.

[4] Langley and Fletcher, *loc. cit.*, 152.

[5] Ibid., p. 132.

indicated shows no constant appreciable influence of alcohol or alcoholic fluids upon the *rate of secretion* of submaxillary (or sublingual) saliva under the influence of a constant external stimulus. Even large doses of alcohol, sufficient to produce prolonged narcosis, fail to check the salivary flow, a result in striking contrast to the effects which morphine may bring about when used in moderately large doses. We have not infrequently observed, in other experiments, an entire absence of salivary flow, even with very strong stimuli, when morphine was unintentionally given in doses larger than were necessary to produce a mild narcosis. On the other hand, there is likewise an absence of any stimulating action on the glands, in our experiments; at least the slight variations in the rate of flow after alcohol is administered are no greater than those brought about by water alone (cf. third protocol above). On the *total solids* likewise, the presence of alcohol seems to exercise no noticeable influence. There is a tendency toward decrease in amount as the experiments progress: this decrease, however, is entirely confined to the *organic constituents* of the saliva, the *salts* remaining comparatively constant in amount, as can be seen in the protocols above. The decrease in organic substances is in no way to be attributed to alcohol, since it may be obtained with water alone (cf. protocol third), or in the course of any protracted salivary secretion. Nor is this decrease remarkable when it is remembered that a small gland weighing a few grams has furnished fifty to seventy-five grams of saliva in the course of three or four hours. The organic constituents of the cells must thus be exhausted somewhat more rapidly than the anabolic processes of the gland can replace them, while the salts are obtained with relative ease from the blood. Any effect upon the secretion of inorganic salts such as might result in accordance with Langley's law (cf. page 263) was not observed. A large number of determinations of the alkalinity of the saliva (towards lacmoid) likewise failed to show any constant relations. It is interesting in this connection to note that the submaxillary saliva of the dog was always found alkaline to phenolphthaleïn, litmus, lacmoid, and methylorange. Mixed human saliva, like the bile of a number of animals, is almost always acid toward phenolphthaleïn.[1]

[1] Chittenden, "The Reactions of Some Animal Fluids," *Science*, N. S. v. 902.

B. GASTRIC SECRETION.

It has already been pointed out that in an accurate and complete study of the influence of alcohol and alcoholic drinks upon gastric digestion, no single line of experimentation can lead to full and concise results covering the whole ground of inquiry. It was therefore deemed advisable, for experimental purposes, to study the subject under several distinct heads, as (1) the influence of alcohol and alcoholic drinks upon the process of secretion; (2) upon the processes of absorption; (3) upon the motor functions of the alimentary canal: and (4) upon the purely chemical processes of gastric digestion. The last phase has already been considered at some length.

The older announcements regarding the influence of alcohol are summarized in the statement that it is a strong stimulant of gastric secretion, and alcohol is recommended as a means of obtaining gastric juice from fistulæ in animals.[1] Larger doses are regarded as detrimental to the stomach, giving rise to transudation of alkaline fluid, — a process evidently pathological.[2] Gluzinski[3] found in experiments on man with brandy and dilute alcohol that these liquors gave rise, after a brief preliminary period, to the formation of a very active secretion rich in hydrochloric acid.

Likewise Wolff[4] states that cognac in small doses increases the secretion of hydrochloric acid, while in larger quantity it decreases the acidity of the gastric juice and retards peptone formation. The stomach fails to respond in a positive way, however, after the continued use of alcohol. While Klemperer[5] failed to note more than a very slight increase in secretion resulting from moderate doses of alcohol, Blumenau[6] ob-

[1] Cf. Frerichs, Wagner's *Handwörterbuch der Physiologie*, 1846, iii. (1), 788; Kühne, *Lehrbuch*, pp. 28, 30; Heidenhain, Hermann's *Handbuch der Physiologie*, v. 115.

[2] Cf. Heidenhain, *loc. cit.*; Lauder Brunton, *Disorders of Digestion*, 1886, p. 144.

[3] Gluzinski, *Deutsches Archiv. f. klin. Med.*, 1886, xxxix. 405. See *Jahresbericht für Thierchemie*, 1886, xvi. 263.

[4] Wolff, *Zeitschr. f. klin. Med.*, 1889, xvi. 222; *Jahresbericht f. Thierchemie*, 1889, xix. 266.

[5] Klemperer, *Zeitschr. f. klin. Med.*, 1890, xvii. Supp., 324; *Centralbl. f. med. Wissen.* 1891, p. 751.

[6] Blumenau, *Therapeutische Monatshefte*, 1890, v. 504; *Jahresbericht f. Thierchemie*, 1891, xx. 212.

served that twenty-five to fifty per cent. alcohol introduced into the healthy human stomach acts as a secretory stimulant, bringing about an increased flow of gastric juice with rise of acidity after a period of two to three hours. More recently Brandl[1] has found in experiments on fistulous dogs that alcohol — as contrasted with water introduced with foodstuffs into the stomach — brings about an unfailing, though not particularly large, increase in gastric secretion. With repeated and increasing doses of alcohol, Haan[2] has further observed an augmentation of acidity in the dog, followed by a diminution in the amount of secretion and a gradual decline in acidity after several doses.

In our first series of experiments on gastric secretion, attention was directed to the volume and acidity resulting from the introduction of alcoholic fluids into the stomach, independently of any stimulating action due to food simultaneously introduced. Dogs in fasting condition were employed in every instance, and morphine sulphate (introduced subcutaneously) followed by chloroform-ether was used preparatory to operative interference. The method consisted in ligating the duodenum just beyond the pylorus and then introducing a definite volume of the fluid to be examined into the empty stomach in the manner already indicated in previous experiments. In several cases, dogs with gastric fistulæ were employed. The abdomen was quickly sewed up after this operation, chloroform-ether stopped and the animal allowed entire freedom of movement. The liquid employed was ordinarily warmed gently to avoid the asserted stimulating action of cold fluids on the gastric mucosa.[3] Ligations of the œsophagus and œsophageal fistulæ were avoided, since a somewhat extended experience with gastric fistulæ dogs, as well as the experiments about to be described, have convinced us, in agreement with Heidenhain's observations,[4] that under ordinary circumstances, i. e., in the absence of unusual stimuli (and with slightly narcotized animals), the amount of saliva secreted is small at most and fails to induce any pronounced secretion in the stomach.[5] Further,

[1] Brandl, *Zeitschr. f. Biologie*, 1892, xxix. 304.

[2] Haan, *Comptes rendus de la société de biologie*, 1895, ii. 817.

[3] Cf. Kühne, *Lehrbuch der physiol. Chemie*, 28.

[4] Hermann's *Handbuch*, v. 112.

[5] Compare also the experiment described on page 260.

we have found that an unusual flow of saliva is at once readily detected by the physical character of the stomach contents, e. g., frothing, etc. Furthermore, the conditions of our experiments were intended to approach those normally obtaining in the body as nearly as possible; and finally, a sufficient number of control experiments in which water was introduced into the stomach have left no doubt as to the validity of the method. At the end of from three to four hours — a period shown by our experiments to cover the digestion time of a test meal for the dog — the animal was bled to death, the œsophagus ligated at the lower end, the stomach removed from the body, wiped free from blood, and the contents discharged into a graduated vessel. In the fluid thus obtained, total acidity, free and combined HCl, and acid-reacting salts were determined by the method of Töpfer:[1] alcohol was estimated, when present, in the distillate from a definite portion of the gastric contents, by the pycnometer method; total solids were determined by drying a weighed quantity of fluid in a tared crucible at 100°–105° C. Protocols follow: —

Control Experiments with Water.

I. 31 v. 1897. Dog, with gastric fistula, well healed Weight 21 kilos. Fluid removed completely through fistula.

Introduced 200 c. c. *distilled water* at 10.50 A. M.
Contents removed at 1.55 P. M. $= 3\frac{1}{12}$ hrs.

Volume of fluid recovered from stomach = 160 c. c. = 80 per cent. of original volume.

Analysis of the contents gave:

Total acidity	0.203 per cent.[2]
Free HCl	0.192
Loosely combined HCl . .	0.002
Salts	0.009
Total solids	0.624

II. 28 vi. 1897. Dog, with gastric fistula, well healed. Weight 25 kilos. Fluid removed completely through fistula.

Introduced 135 c. c. *distilled water* at 11 A. M.
Contents removed at 1.45 P. M. $= 2\frac{3}{4}$ hrs.

Volume of fluid recovered from stomach = 110 c. c. = 81 per cent. of original volume.

[1] Töpfer, *Zeitschr. f. physiol. Chemie*, 1894, xix. 104.
[2] Expressed as HCl in all the experiments.

Analysis of the contents gave :

Total acidity	0.274 per cent.
Free HCl	0.241
Loosely combined HCl . . .	0.018
Salts	0.015
Total solids	0.77

III. 24 v. 1897. Dog. Weight 7.7 kilos.

Introduced 125 c. c. *distilled water* at 10 A. M.

Contents removed at 1.50 P. M. = $3\frac{5}{6}$ hours.

Volume of fluid recovered from stomach = 114 c. c. = 91 per cent. of original volume.

Analysis of the contents gave :

Total acidity	0.094 per cent.
Free HCl	0.065
Loosely combined HCl . .	0.004
Salts	0.025
Total solids	0.47

IV. 29 v. 1897. Dog. Weight 14.5 kilos.

Introduced 200 c. c. *distilled water* at 9.30 A. M.

Contents removed at 1.15 P. M. = $3\frac{3}{4}$ hours.

Volume of fluid recovered from stomach = 206 c. c. = 103 per cent. of original volume.[1]

Analysis of the contents gave :

Total acidity	0.047 per cent.
Free HCl	0.040
Loosely combined HCl . .	0.004
Salts	0.003
Total solids	0.50

V. 2 vi. 1897. Dog. Weight 10.5 kilos.

Introduced 125 c. c. *carbonated water* at 9 A. M.

Contents removed at 12.45 P. M. = $3\frac{3}{4}$ hours.

Volume of fluid recovered from stomach = 125 c. c. = 100 per cent. of original volume.

Analysis of the contents gave :

Total acidity	0.191 per cent.
Free HCl	0.152
Loosely combined HCl . . .	0.014
Salts	0.025
Total solids	0.55

In this experiment the CO_2 was completely absorbed.

VI. 1 vii. 1897. Dog. Weight 10 kilos.

Introduced 76 c. c. of 2 per cent. *dextrose* solution at 9.10 A. M.

[1] A small quantity of saliva doubtless found its way into the stomach, as the dog salivated somewhat at the beginning of the operation and the stomach contents had a frothy appearance.

Contents removed at 12.10 P. M. = $3\frac{1}{2}$ hours.

Volume of fluid recovered from stomach = 68 c. c. = 90 per cent. of original volume.

Analysis of the contents gave :

Total acidity	0.072 per cent.
Free HCl	0.047
Loosely combined HCl . . .	0.007
Salts	0.018

Experiments with Strong Ethyl Alcohol.

VII. 17 v. 1897. Dog. Weight 23 kilos.

Introduced 200 c. c. of 37 per cent. *alcohol* at 10.45 A. M.

Contents removed at 2.15 P. M. = $3\frac{1}{2}$ hours.

Volume of fluid recovered from stomach = 407 c. c. = 203 per cent. of original volume.

Analysis of the contents gave :

Total acidity	0.164 per cent.
Free HCl	0.112
Loosely combined HCl . . .	0.043
Salts	0.009

VIII. 31 v. 1897. Dog. Weight 21 kilos. Gastric fistula well healed.

Contrast experiment with water and alcohol.

a. The first part of this experiment has been described under I. page 267.

β. After discharge of previous stomach contents completely through fistula, 200 c. c. $37\frac{1}{2}$ per cent. *alcohol* were introduced into the stomach through fistula at 1.55 P. M.

Contents removed at 5 P. M. = $3\frac{1}{12}$ hours.

Volume of fluid recovered from stomach = 460 c. c. = 230 per cent. of original volume.[1]

Analysis of the contents gave :

Total acidity	0.220 per cent.
Free HCl	0.164
Loosely combined HCl . . .	0.011
Salts	0.045
Total solids	0.987

Experiments with Weak (5 per cent.) Ethyl Alcohol.

IX. 24 vi. 1897. Bitch. Weight 8 kilos.

Introduced 100 c. c. 5 per cent. *alcohol* at 10.45 A. M.

Contents removed at 2 P. M. = $3\frac{1}{4}$ hours.

Volume of fluid recovered from stomach = 110 c. c. = 110 per cent. of original volume.

Analysis of the stomach contents gave :

[1] A post-mortem examination showed that the stomach contents could be completely discharged through the fistula by the method adopted.

Total acidity	0.119 per cent.
Free HCl	0.086
Loosely combined HCl . . .	0.011
Salts	0.022
Total solids	0.69

X. 8 vi. 1897. Bitch. Weight 7.3 kilos.

Introduced 110 c. c. 4.8 per cent. *alcohol* at 9 A. M.

Contents removed at 12.45 P. M. = $3\frac{3}{4}$ hours.

Volume of fluid recovered from stomach = 135 c. c. = **123 per cent.** of original volume.

Analysis of the stomach contents gave :

Total acidity	0.202 per cent.
Free HCl	0.148
Loosely combined HCl . . .	0.021
Salts	0.033

The results of the foregoing experiments, expressed in percentages, are combined in the following table : —

A. With water.	Relative volume of fluid at end of experiment.	Total acidity.	Loosely combined HCl.	Free HCl.	Salts.	Total solids.
I	80	0.203	0.002	0.192	0.009	0.62
II	81	0.274	0.018	0.241	0.015	0.77
III	91	0.094	0.004	0.065	0.025	0.47
IV	103	0.047	0.004	0.040	0.003	0.50
V	100	0.191	0.014	0.152	0.025	0.55
VI	90	0.072	0.007	0.047	0.018	–
Average.	90.8	0.147	0.008	0.123	0.016	0.58

B. With strong alcohol.	Relative volume of fluid at end of experiment.	Total acidity.	Loosely combined HCl.	Free HCl.	Salts.	Total solids.
VII	203	0.164	0.043	0.112	0.009	–
VIII	230	0.220	0.011	0.164	0.045	0.99
Average.	216.5	0.192	0.027	0.138	0.026	0.99

C. With weak alcohol.	Relative volume of fluid at end of experiment.	Total acidity.	Loosely combined HCl.	Free HCl.	Salts.	Total solids.
IX	110	0.119	0.011	0.086	0.022	0.69
X	123	0.202	0.021	0.148	0.033	–
Average.	116.5	0.160	0.016	0.117	0.027	0.69

A glance at the data presented leaves little doubt as to the pronounced stimulating action of pure ethyl alcohol upon gastric secretion, even with solutions of only five per cent. strength. The effect is not merely one characterized by the discharge of water into the stomach cavity, but gives evidence of a true secretory process. Thus, the volume of fluid found after introduction of water into the stomach is not increased, there being rather a tendency in the opposite direction. Edkins,[1] v. Mering,[2] and others have shown that the absorption of water from the stomach is practically *nil*, while the absorption of alcohol goes on quite rapidly. In our own experiments the alcohol used had entirely disappeared from the stomach in the course of the experiments: the question of absorption will, however, be referred to in another connection. With five per cent. alcohol the increase in the volume of the gastric contents is noticeable, becoming very pronounced with the stronger percentages of alcohol. The increase in total solids gives confirmation of stimulated secretion, as does also the increase in acidity. It must be remembered, further, that the increase in acidity shown by the figures is a relative one; expressed absolutely in grams, the total acid secreted is obviously increased in far greater degree than the percentage figures indicate. The specific action of alcohol is strikingly shown in Experiment VIII., in which the conditions permitted of comparative experiments with water and alcohol on the same animal, with the following results: —

Comparison of the Two Experiments (VIII. α. β).

Fluid introduced into stomach.	Fluid recovered from stomach after three hours.	Relative volume.	Total acidity.	Free HCl.	Loosely combined HCl.	Salts.	Total solids.
200 c. c. water	160 c. c.	80%	0.203	0.192	0.002	0.009	0.624
200 c. c. alcohol (37½ per cent.)	460 c. c.	230%	0.220	0.164	0.011	0.045	0.987

A comparison of the proteolytic activity of the two secretions by Grützner's carmine-fibrin method showed a decidedly greater

[1] Edkins, *Journal of Physiology*, 1892, xiii. 445.

[2] v. Mering, *Verhandlungen des XII. Congresses f. innere Medicin*, Wiesbaden, 1893; *Therapeutische Monatshefte*, 1893, vii. 201.

digestive power in the case of the "water" secretion. Much stress cannot be placed, however, on a single experiment. The gastric fluids obtained in the experiments with alcohol possessed strong proteolytic properties in every case examined.

In view of this pronounced action of alcohol on gastric secretion it seemed desirable to ascertain something more definite regarding the way in which this process is provoked. The control experiments with water gave evidence that the mere contact of the fluid with the stomach mucosa could not be the cause of gastric stimulation. It will be remembered that even vigorous mechanical stimulation or irritation ordinarily fails to yield more than a few grams of secretion,[1] — an observation in decided contrast to the phenomena of gastric flow during the presence of digestible materials in the stomach. The following experiments throw light on the question raised: —

XI. 25 v. 1897. Dog. Weight 23 kilos. The intestine was ligatured just beyond the pylorus. Another ligature was applied below the point of entrance of the duct of Wirsung. 20 c. c. of 60 per cent. alcohol were injected into the lumen of the intestine between these ligatures, while 105 c. c. of 60 per cent. alcohol were introduced into the intestine beyond the second ligature. Then

Introduced 200 c. c. *water* into stomach at 10.45 A. M.

Contents removed at 2.30 P. M. = $3\frac{3}{4}$ hours.

Volume of fluid recovered from stomach = 260 c. c. = 130 per cent. of original volume.

Analysis of stomach contents gave:

Total acidity	0.241 per cent.
Free HCl	0.213
Loosely combined HCl . . .	0.002
Salts	0.026

XII. 28 v. 1897. Bitch. Weight 28 kilos. Intestine ligatured just beyond the pylorus. Another ligature was applied below the point of entrance of the duct of Wirsung. 125 c. c. of 60 per cent. alcohol were injected into the lumen of the intestine below the second ligature.[2] Then

Introduced 200 c. c. *water* into stomach at 11 A. M.

Contents removed at 2.45 P. M. = $3\frac{3}{4}$ hours.

Volume of fluid recovered from stomach = 375 c. c. = 187.5 per cent. of original volume.

[1] Cf. Tiedemann and Gmelin. *Die Verdauung nach Versuchen*. 1831, p. 92; Schiff, *Leçons sur la physiologie de la digestion*, ii. 244.

[2] The return of alcoholic fluid into the stomach was thus absolutely prevented.

Analysis of stomach contents gave :

Total acidity	0.333 per cent.
Free HCl	0.306
Loosely combined HCl . . .	0.004
Salts	0.023
Total solids	0.30

SUMMARY OF RESULTS OF EXPERIMENTS.

No.	Relative volume of fluid at end of experiment.	Total acidity.	Loosely combined HCl.	Free HCl.	Salts.	Total solids.
XI	130.0	0.241	0.002	0.213	0.026	–
XII	187.5	0.333	0.004	0.306	0.023	0.30
Average.	158.5	0.287	0.003	0.259	0.024	0.30

From these data it seems clear that a stimulation of the gastric glands may take place, independently of any *direct* gastric irritation, in consequence of the influence of alcohol absorbed from the intestine. The volume of the fluid in the stomach increased relatively far more than when five per cent. alcohol was introduced directly into the stomach (cf. Experiments IX., X., pages 269, 270). The composition of the fluid (high acidity, free HCl, total solids) likewise gives evidence of active secretion, while the fluid was found to be strongly proteolytic. The absorption of the alcohol was complete in these experiments; and when it is remembered how quickly alcohol is distributed and disappears in the body, the actual amount reaching the gastric glands must have been relatively small, or at least must have acted during a brief period only. It seems probable, therefore, that there occurs here an indirect stimulation quite comparable to that resulting after absorption of peptone from the alimentary tract, and it is interesting to note by way of comparison that Khigine,[1] in his experiments upon the isolated fundus of the dog, found that the acidity of the secretion after absorption of digestion products runs parallel to a certain degree with the increase in volume. Whether the absorbed alcohol acts directly upon elements of the gastric mucosa (Heidenhain's "secondary secretion"), or becomes a stimulus to spe-

[1] Khigine, *Archives des sciences biologiques*, St. Petersbourg, 1895, iii. 461.

cific secretory nerve fibres (Khigine), we are unable at present to decide.[1]

In connection with this "secondary" secretion of gastric juice due to the presence of alcohol in the small intestine, it is to be noted that Macfadyen, Nencki, and Sieber[2] found among the bacteria normally present in this portion of the alimentary canal species which give rise to a production of ethyl alcohol from carbohydrates ingested.

Experiments with Alcoholic Beverages.

It might naturally be assumed that the action of the various alcoholic beverages on gastric secretion would be similar, qualitatively, to that of their common constituent, ethyl alcohol. Previous investigation, however, has shown that the influence of these liquors on the purely chemical processes of digestion is not necessarily proportionate to their content of alcohol;[3] hence it seemed desirable to study the effect of a number of typical liquors on secretion, by the method of the previous experiments. This we have done with the following results: —

XIII. 21 vi. 1897. Dog. Weight 10.7 kilos.

Introduced 50 c. c. **sherry** + 25 c. c. *water* (14 per cent. alcohol) at 10.20 A. M.

Contents removed at 2.15 P. M. = $3\frac{11}{12}$ hours.

Volume of fluid recovered from stomach = 160 c. c. = **213 per cent.** original volume.

Analysis of stomach contents gave :

Total acidity	0.367 per cent.
Free HCl	0.300
Loosely combined HCl . .	0.020
Salts	0.047
Total solids	1.72

XIV. 2 vi. 1897. Dog. Weight 18.5 kilos.

Introduced 50 c. c. *whiskey* + 100 c. c. *water* (16 per cent. alcohol) at 11.15 A. M.

Contents removed at 3 P. M. = $3\frac{3}{4}$ hours.

Volume of fluid recovered from stomach = 320 c. c. = **213 per cent.** original volume.

Analysis of stomach contents gave :

[1] Cf. Howell, *American Text-Book of Physiology*, 1896, p. 182.

[2] Macfadyen, Nencki, and Sieber, *Archiv f. experimentelle Pathologie und Pharmakologie*, 1891, xxviii. 311.

[3] Chittenden and Mendel, *loc. cit.*

Total acidity	0.382 per cent.
Free HCl	0.346
Loosely combined HCl . .	0.011
Salts	0.025
Total solids	0.42

XV. 3 vi. 1897. Bitch. Weight 8 kilos.

Introduced 125 c. c. hochheimer (13.3 per cent. alcohol) at 10 A. M.

Contents removed at 1.45 P. M. = $3\frac{3}{4}$ hours.

Volume of fluid recovered from stomach = 140 c. c. = 112 per cent. original volume.

Analysis of stomach contents gave :

Total acidity	0.230 per cent.
Free HCl	0.165
Loosely combined HCl . .	0.038
Salts	0.027

XVI. 28 vi. 1897. Dog. Weight 25 kilos. Gastric fistula well healed.

Contrast experiment with water and wine.

α. The first part of this experiment has been described under II., page 267.

β. After complete discharge of previous stomach contents through the fistula, 135 c. c. white wine were introduced into stomach through fistula at 1.45 P. M.

Contents removed at 4.30 P. M. = $2\frac{3}{4}$ hours.

Volume of fluid recovered from stomach = 170 c. c. = 126 per cent. original volume.

Analysis of stomach contents gave :

Total acidity	0.425 per cent.
Free HCl	0.342
Loosely combined HCl . .	0.018
Salts	0.065
Total solids	1.79

XVII. 23 vi. 1897. Dog. Weight 12.3 kilos.

Introduced 125 c. c. claret (5.15 per cent. alcohol) at 9.30 A. M.

Contents removed at 1.30 P. M. = 4 hours.

Volume of fluid recovered from stomach = 225 c. c. = 180 per cent. original volume.

Analysis of stomach contents gave :

Total acidity	0.373 per cent.
Free HCl	0.324
Loosely combined HCl . .	0.025
Salts	0.024
Total solids	1.90

XVIII. 18 vi. 1897. Bitch. Weight 10.2 kilos.

Introduced 100 c. c. lager beer (4 to 5 per cent. alcohol) at 10.20 A. M.

Contents removed at 2.15 P. M. = $3\frac{11}{12}$ hours.

Volume of fluid recovered from stomach = 110 c. c. = 110 per cent. original volume.

Analysis of stomach contents gave :

Total acidity	0.357 per cent.
Free HCl	0.241
Loosely combined HCl . .	0.064
Salts	0.052
Total solids	9.26

XIX. 23 vi. 1897. Dog. Weight 10 kilos.

Introduced 100 c. c. lager beer (4.5 per cent. alcohol) at 10.10 A. M.

Contents removed at 2 P. M. = $3\frac{5}{6}$ hours.

Volume of fluid recovered from stomach = 125 c. c. = 125 per cent. original volume.

Analysis of stomach contents gave :—

Total acidity	0.241 per cent.
Free HCl	0.169
Loosely combined HCl . .	0.032
Salts	0.040
Total solids	5.51

XX. 14 vi. 1897. Dog. Weight 14 kilos.

Introduced 150 c. c. porter (3.75 per cent. alcohol) at 9.45 A. M.

Contents removed at 1.30 P. M. = $3\frac{3}{4}$ hours.

Volume of fluid recovered from stomach = 195 c. c. = 127 per cent. original volume.

Analysis of stomach contents gave :

Total acidity	0.371 per cent.
Free HCl	0.320
Loosely combined HCl . . .	0.036
Salts	0.015
Total solids	2.19

XXI. 7 vi. 1897. Bitch. Weight 8.5 kilos.

Introduced 125 c. c. lager beer (4.7 per cent. alcohol) at 10.15 A. M.

Contents removed at 2.10 P. M. = $3\frac{11}{12}$ hours.

Volume of fluid recovered from stomach = 285 c. c. = 228 per cent. original volume.

Analysis of stomach contents gave:

Total acidity	0.378 per cent.
Free HCl	0.308
Loosely combined HCl . . .	0.016
Salts	0.054
Total solids	2.88

XXII. 14 vi. 1897. Dog. Weight 8.2 kilos.

Introduced 150 c. c. porter residue[1] at 11.30 A. M.

Contents removed at 3.15 P. M. = $3\frac{3}{4}$ hours.

Volume of fluid recovered from stomach = 135 c. c. = 90 per cent. original volume.

Analysis of stomach contents gave:

Total acidity	0.352 per cent.
Free HCl	0.280
Loosely combined HCl . . .	0.014
Salts	0.058
Total solids	2.29

XXIII. 9 vi. 1897. Dog. Weight 10 kilos.

Introduced 130 c. c. lager beer residue[2] at 10.30 A. M.

Contents removed at 2.30 P. M. = 4 hours.

Volume of fluid recovered from stomach = 175 c. c. = 134 per cent. original volume.

Analysis of stomach contents gave:

Total acidity	0.346 per cent.
Free HCl	0.270
Loosely combined HCl . . .	0.038
Salts	0.038
Total solids	6.80

For the sake of comparison these data are contrasted in the following table: —

[1] The residue left on evaporation of 150 c. c. porter, dissolved in 150 c. c. distilled water.

[2] Residue from evaporation of 130 c. c. beer, dissolved in 130 c. c. water.

	Relative vol. of fluid at end of experiment.	Total acidity.	Loosely combined HCl.	Free HCl.	Salts.	Total solids.
XIV. Whiskey + H_2O . (16% alcohol)	213	0.382	0.011	0.346	0.025	0.42
XIII. Sherry + H_2O . (13% alcohol)	213	0.367	0.020	0.300	0.047	1.72
XV. White wine . . . (13% alcohol)	112	0.230	0.038	0.165	0.027	–
XVI. White wine . . . (13% alcohol)	126	0.425	0.018	0.342	0.065	1.79
XVII. Claret . . . . (10% alcohol)	180	0.373	0.025	0.324	0.024	1.90
XVIII. Beer . . . . . (4.7% alcohol)	110	0.357	0.064	0.241	0.052	9.26
XIX. Beer . . . . . (4% alcohol)	125	0.241	0.032	0.169	0.040	5.51
XXI. Beer . . . . . (4.7% alcohol)	228	0.378	0.016	0.308	0.054	2.88
XXIII. Residue of beer . (like XXI.)	134	0.346	0.038	0.270	0.038	6.80
XX. Porter . . . . (5.3% alcohol)	127	0.371	0.036	0.320	0.015	2.19
XXII. Residue of porter (like XX.)	90	0.352	0.014	0.280	0.058	2.29

These results afford tangible evidence of the stimulating action of the liquors examined, as shown in the increased volume of gastric contents, accompanied by increase in acidity. That alcohol is an important factor in the production of these phenomena seems certain. Contrast, for example, Experiment XX. with XXII., which differs only in the absence of the alcohol. But the wines and malted beverages contain a variety of other constituents, such as organic acids, which perhaps contribute to increase the stimulating effect and are doubtless partly responsible in a number of experiments for the high acidity observed. The contrast between the action of water and wine is strikingly shown in Experiments XVI. α and β, carried out on the same animal.

Comparison of the Two Experiments (XVI. α, β).

Fluid introduced into stomach.	Fluid removed from stomach after 3 hours.	Relative volume. per cent.	Total acidity.	Free HCl.	Loosely combined HCl.	Salts.	Total solids.
135 c. c. water	110 c. c.	81	0.274	0.241	0.018	0.015	0.77
135 c. c. white wine . . .	170 c. c.	126	0.425	0.342	0.018	0.065	1.79

The marked increase in total solids in many of these experiments, however, is not to be attributed, as in the case of pure alcohol, entirely to the increased secretion; it is rather in part accounted for by the unabsorbed constituents of the liquor employed. The following table, compiled from analyses at hand, shows that a large portion of the total solids in the gastric juices obtained may be derived from other sources than the secretion itself: —

Table showing Total Solids of Gastric Contents.

Nature of fluid introduced into stomach.	Total solids introduced into stomach.	Total solids in gastric contents at end of experiment.
II. Water	0 grams.	0.84 grams.
IX. Weak alcohol	0 "	0.69 "
VIII. Strong alcohol	0 "	4.50 "
XIV. Whiskey	0.15 "	1.34 "
XVI. White wine	2.8 "	2.41 "
XVII. Claret	3.9 "	4.28 "
XIII. Sherry	2.35 "	2.78 "
XVIII. Beer	7.0 "	10.00 "
XXIII. Beer residue	9.1 "	11.56 "
XX. Porter	6.6 "	4.16 "
XXII. Porter residue	6.6 "	3.10 "

Character of the Gastric Juice obtained by Stimulation with Alcohol.

The gastric juice obtained as a result of the stimulating influence of alcohol and alcoholic liquors resembles that ordinarily procured from gastric fistulæ in its physical characters: it is a thin, colorless, or very faintly yellow fluid containing occasional flocks of mucus in suspension. There was no evidence of irritation or hyperæmia of the mucosa, and all traces of blood were absent. After the doses used the gastric lining was of a pale or faintly pink color when removed after bleeding

the animal. When colored alcoholic liquors were employed the gastric contents retained the characteristic coloring matter, the latter not being absorbed, while the alcohol entirely disappeared. In chemical composition the gastric juice appeared somewhat more acid than that ordinarily secreted. It likewise contained a larger amount of solid matter, and in harmony with this fact the proportion of combined hydrochloric acid was increased, which in turn suggests the presence of a somewhat larger amount of proteid or other like matter. The fluids were repeatedly tested with boiled fibrin for proteolytic action, and this was always found vigorous. In the experiments in which alcohol was introduced directly into the intestines (Experiments XI., XII., page 272) the intestinal lining was not abnormal in appearance, the reaction being alkaline to litmus in the upper duodenum and neutral or faintly alkaline farther along the alimentary canal. This corresponds with the observations on the normal reaction of the intestinal contents of the dog, by Moore and Rockwood,[1] whose statements we have repeatedly verified.

C. GASTRIC DIGESTION.

Since chemical, mechanical, and physiological processes go on side by side during digestion, we have carried out a series of experiments to determine in what way and to what extent the factors already investigated combine or coöperate under the influence of alcohol and alcoholic liquors. Our method has included the examination of the stomach contents after test meals were given. The statements current in the literature on this subject are by no means concordant.

In experiments on a woman having a gastric fistula Kretschy[2] observed that alcohol retarded digestion. Buchner[3] found that in the human stomach alcohol, wine, and beer all retarded digestion, though not so markedly as in artificial digestion. Bikfalvi,[4] in observations on dogs, obtained a retardation of digestion with even small quantities of alcohol. Beer and wine

[1] Moore and Rockwood, *Journal of Physiology*, 1897, xxi. 373.

[2] Kretschy, *Deutsches Arch. f. klin. Med.*, xviii. 527; *Jahresbericht f. Thierchemie*, 1876, vi. 173.

[3] Buchner, *Deutsches Arch. f. klin. Med.*, xxix. 537; *Jahresbericht f. Thierchemie*, 1881, xi. 286.

[4] Bikfalvi, *Jahresbericht f. Thierchemie*, 1885, xv. 273.

showed no favorable influence, the latter even retarding digestion when given in large quantities. Ogáta[1] states that beer, wine, and brandy retard gastric digestion noticeably. Schelhaas[2] observed that in the living stomach wine did not retard digestion so long as there was free HCl present: pathological conditions (carcinoma ventriculi) formed the only exceptions. In an extensive series of experiments Gluzinski[3] distinguishes two phases occurring during digestion in the stomach in the presence of alcohol: (1) a retardation of proteid digestion, and (2) secretion of a very active, strongly acid gastric juice. Henczinski[4] found no bad effect on digestion following the use of beer. Blumenau[5] states that from twenty-five to fifty per cent. of alcohol introduced into the healthy stomach induces a decrease in digestive action during the first two or three hours. Wolffhardt,[6] experimenting on a healthy man, concluded that from fifteen to twenty grams of absolute alcohol interfere with proteid digestion, while the effect of cognac varies with the period of digestion during which it is taken: he found that wines tend to promote digestion.

With reference to the motor functions of the stomach Lauder Brunton states that alcohol taken into this organ increases its movements as well as its secretory activity, and by mixing its contents more thoroughly with the gastric juice accelerates digestion.[7] Likewise Klemperer[8] states as a result of his experiments that the motor functions are decidedly increased as measured by the oil method, while Haan[9] has more recently ad-

[1] Ogáta, *Jahresbericht f. Thierchemie*, 1885, xv. 274; *Arch. f. Hygiene*, 1885, iii. 204.

[2] Schelhaas, *Deutsches Arch. f. klin. Med.*, xxxvi. 427; *Jahresbericht f. Thierchemie*, 1885, xv. 271.

[3] Gluzinski, *Deutsches Arch. f. klin. Med.*, 1886, xxxix. 405; *Jahresbericht f. Thierchemie*, 1886, xvi. 263.

[4] Henczinski, *Dissertation*, 1886. Quoted by Munk, *Die Ernährung*, p. 327.

[5] Blumenau, *Therapeutische Monatshefte*, 1890, v. 504; *Jahresbericht f. Thierchemie*, 1891, xxi. 212.

[6] Wolffhardt, *Münchn. med. Wochenschr.*, 1890, xxxvii. 608; *Centralbl. f. med. Wissen.*, 1891, p. 47.

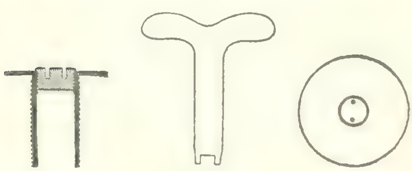
[7] Brunton, *Disorders of Digestion*, 1886, p. 146.

[8] Klemperer, *Zeitschr. f. klin. Med.*, 1890, xvii. Supp., p. 324; *Centralbl. f. med. Wissen.*, 1891, p. 751.

[9] Haan, *Comptes rendus de la société de biologie*, 1895, ii. 816.

vanced similar conclusions as the result of work by another method. Gluzinski,[1] however, notes that alcohol diminishes the mechanical action of the stomach in moderate degree.

In considering the selection of subjects for experiment in the direction indicated, preference has been given to dogs. The series of investigations on man above referred to are already extensive, and the difficulties of obtaining definite answers to specific questions by this method of experimentation are obvious. It is rarely possible or desirable to carry out a large number of determinations on any single individual, while it is likewise practically impossible to control the physiological condition of the individual, i. e., diet, etc., over prolonged periods. The animals used in this research were large dogs of twenty-one and twenty-five kilos; gastric fistulæ were made, and a German-silver cannula introduced into the fundus of the stomach. In place of a cork, metal stoppers were devised to screw into the inner cannula tube by means of a small metallic key. The arrangement is shown in the diagram. The wounds healed perfectly and the animals remained in good health during the entire period of investigation, covering several months. Irregularities of diet were avoided by feeding definite portions of prepared dog biscuit with water; this food was eagerly eaten and sufficed to keep the dogs in physiological equilibrium.



The determinations of the acidity of the stomach contents were carried out according to the method of Töpfer.[2] The gastric fluid was occasionally centrifugalized when food particles prevented pipetting off the fluid portion. Where only small quantities of fluid were available the titrations with phenolphthalién and dimethylamidoazobenzol were combined in the same five c. c. of fluid, according to the recommendation of Einhorn.[3] Comparative experiments show that this modification gives the same values as the original method. Thus in one experiment: —

[1] Gluzinski, *loc. cit.*

[2] Töpfer, *Zeitschr. f. physiol. Chemie*, 1894, xix. 104.

[3] Einhorn, *New York Medical Journal*, 1896, May 9, p. 603.

	Total acidity with *Phenolphthalein.*	Free HCl with *Dimethylamidoazobenzol.*
Töpfer method . . . (separate titrations)	1.55 c. c. $\frac{N}{10}$NaOH = 0.112 per cent. HCl.	1.0 c. c. $\frac{N}{10}$NaOH = 0.072 per cent. HCl.
Einhorn-Töpfer method (combined titration)	1.55 c. c. $\frac{N}{10}$NaOH = 0.112 per cent. HCl.	1.0 c. c. $\frac{N}{10}$NaOH = 0.072 per cent. HCl.

Our experience with Töpfer's method (or Einhorn's modification) leads us to agree with P. Häri[1] that in the absence of free HCl, i. e., when no reaction is obtained with the dimethylamidoazobenzol reagent, the quantitative determinations of HCl by this method cease to be accurate, and under such conditions it cannot be employed. The occurrence of such conditions, however, is not frequent in the dog; we have observed the absence of free HCl (during digestion) in one animal under circumstances resembling those of acute gastric catarrh.[2] The food — dog biscuit — was largely undigested many hours after the meal, the acidity was high (0.55 to 0.594 per cent. expressed as HCl), and the gastric contents possessed an odor strongly suggesting fatty acids. Lactic acid was found present (Uffelman's test).

In view of the increased volume of fluid found in the stomach when alcohol is introduced into that organ after ligation of the pylorus, it was of interest to learn what results follow under normal conditions of the pylorus. For this purpose from twenty to twenty-five per cent. alcohol, slightly warmed, was introduced through the gastric cannula, and at the end of thirty minutes the gastric contents were discharged into a graduated vessel. Control experiments were made with distilled water, both fluids always being introduced into the empty stomach. This condition of the organ is shown by the lack of spontaneous flow when the cannula is opened, as well as by ab-

[1] Häri, P., *Arch. f. Verdauungskrankh.*, ii. 182, 332; *Centralbl. f. Physiologie*, 1896, x. 731.

[2] Cf. v. Jaksch, *Klinische Diagnostik innerer Krankheiten*, 4te Auflage, p. 200.

sence of free HCl. Flocks of mucus, alkaline to litmus, are usually present. The data obtained show no marked agreement, the fluid as a rule rapidly disappearing from the stomach. In seventeen experiments with water the *average* relative volume recovered from the stomach through the cannula at the end of the thirty minutes after introduction of quantities from 40 to 200 c. c. was about thirty per cent. Fourteen similar experiments with alcohol gave an average of forty-five per cent. It is natural to ascribe the relatively greater volumes found in the stomach after the use of alcohol to an increased secretion of gastric juice occurring along with the rapid expulsion of fluid through the pylorus, and not to a retardation of the motor functions; for current statements assume increased motility of the stomach under the influence of alcohol,[1] while the experiments already reported justify the explanation given. Much emphasis cannot, however, be placed upon the averages given above, since the individual results vary widely among themselves and no constant corresponding variations in acidity were observed, as in the experiments with ligated pylorus.

In the following series of experiments test meals were given and the influence of alcohol and a considerable number of alcoholic beverages contrasted with that of water. Attention was directed to (1) variations in acidity and (2) time of digestion. Fifty grams of finely chopped lean meat were fed to the dog in each experiment, the stomach having been previously examined and found empty. Meat was chosen for the test meal because experience in this laboratory has shown that its composition, when it is obtained as described, does not vary much from time to time: and after a trial of mixed food, e. g., dog biscuit, it seemed more satisfactory to employ a simple diet in which proteid preponderated. Similar recommendation is made by v. Jaksch in considering test meals for the human subject.[2] Alcoholic fluids or water were introduced slightly warmed[3] into the stomach through the fistula, since dogs usually refuse to take the former by way of the mouth. At definite intervals of one quarter to one half hour small quantities of gastric contents were permitted to flow out of the fistula. Total acidity

[1] Cf. references, pp. 280, 281. [2] v. Jaksch, *loc. cit.*, p. 192.
[3] Cf. note 3, p. 266.

(expressed as HCl), free and loosely combined HCl were determined by the method already described. The process of digestion in the stomach lasted, under the conditions described, about three hours, the average duration varying somewhat with the animal.[1] There was no very gradual diminution of undissolved meat particles noticeable until toward the end of this period, when the stomach very soon became empty. This corresponds with the observations of Kühne on man and the dog in experiments with duodenal fistulæ.[2] This investigator found only a slight disappearance of contents from the stomach until near the end of the digestion period, when the great bulk of material, excepting larger pieces of food, was discharged at once through the pylorus. Richet arrived at similar conclusions in experiments on man.[3] We have usually observed a complete emptying of the stomach within a period of thirty minutes; the conclusion of this process is designated in the notes as the "end of gastric digestion." Protocols of experiments follow: —

Analyses of Alcoholic Beverages used.

	Alcohol by volume. Per cent.	Dry solids. Per cent.		Alcohol by volume. Per cent.	Dry solids. Per cent.
Gin	51.0	0.29	Stout	6.2	5.4
Whiskey . . .	50.0	0.32	Claret . . .	5.2	3.2
Sherry . . .	21.75	4.7	Porter . . .	5.3	4.4
White wine . .	13.32	2.5	Beer	4–5	7.0

DOG A. — Weight 25 kilos.

I. 9.25 A. M. 50 grams meat (no water).

	Analysis of contents. Total acidity.	Loosely combined HCl.	Free HCl.
9.55	0.382	0.292	0.104
10.35	0.425	0.234	0.148
11.10	0.425	0.220	0.180
11.45	0.407	0.224	0.176

12.15 Stomach empty; end of gastric digestion.

Time of digestion = **2 hours and 55 minutes.**

[1] In experiments on a man, with a similar meal, Jessen found the digestion time equaled two to three hours. *Zeitschr. f. Biologie*, 1883, xix. 149.

[2] Kühne, *Lehrbuch der physiol. Chemie*, 1868, p. 53.

[3] Richet, quoted in Gamgee, *Physiological Chemistry*, 1893, ii. 159.

II. 9.10 A. M. 50 grams meat + **50 c. c. water.**

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.30	0.241	0.144	0.093
10.00	0.295	0.169	0.108
10.20	0.367	0.216	0.115
10.40	0.439	0.288	0.144

11.30 Stomach empty; end of gastric digestion.
Time of digestion = **2 hours and 20 minutes.**

III. 9.30 A. M. 50 grams meat + **100 c. c. water.**

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
10.00	0.299	0.173	0.090
10.30	0.475	0.230	0.122
11.00	0.518	0.230	0.173
11.15	0.497	0.202	0.241
11.35	0.494	0.191	0.202
11.50	0.479	0.205	0.195
12.10	0.382	0.194	0.187

12.30 Stomach empty; end of gastric digestion.
Time of digestion = **3 hours.**

IV. 2.10 P. M. 50 grams meat + **150 c. c. water.**

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
2.40	0.252	0.137	0.108
3.10	0.374	0.194	0.130
3.40	0.533	0.245	0.198
3.55	0.547	0.234	0.234
4.10	0.490	0.205	0.216
4.25	0.385	–	0.101

4.40 Stomach empty; end of gastric digestion.
Time of digestion = **2 hours and 30 minutes.**

V. 9.05 A. M. 50 grams meat + **150 c. c. carbonated water.**

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.35	0.263	0.083	0.122
10.05	0.360	0.158	0.140
10.35	0.468	0.194	0.216
10.50	0.486	0.205	0.216
11.05	0.540	0.234	0.198
11.25	0.580	0.234	0.248

11.45 Stomach empty; end of gastric digestion.
Time of digestion = **2 hours and 40 minutes.**

VI. 1.00 P. M. 50 grams meat + 100 c. c. 10 per cent. alcohol.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
2.45	0.497	0.209	0.230
3.10	0.464	0.220	0.173
3.30	0.436	0.180	0.202
3.50	0.400	0.162	0.202
4.10	0.263	–	0.094

4.30 Stomach empty; end of gastric digestion.
Time of digestion = 3 hours and 30 minutes.

VII. 2.30 P. M. 50 grams meat + 50 c. c. 20 per cent. alcohol.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
3.00	0.313	0.118	0.090
3.30	0.374	0.187	0.176
4.00	0.439	0.194	0.151
4.30	0.515	0.205	0.184
5.00	0.407	0.144	0.248
5.30	0.264	–	0.155

5.30 Stomach nearly empty ; end of gastric digestion.
Time of digestion = 3 hours.

VIII. 12.45 P. M. 50 grams meat + 50 c. c. 20 per cent. alcohol.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
2.30	0.439	0.213	0.158
2.50	0.457	0.191	0.205
3.10	0.493	0.205	0.227
3.30	0.364	0.129	0.187

3.50 Stomach practically empty; end of gastric digestion.
Time of digestion = 3 hours and 5 minutes.

IX. 9.15 A. M. 50 grams meat + 50 c. c. 30 per cent. alcohol.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.40	0.191	0.130	0.058
10.05	0.335	0.155	0.151
10.30	0.421	0.176	0.180
10.50	0.468	0.184	0.201
11.10	0.460	0.165	0.220
11.30	0.410	0.148	0.220
11.50	0.468	0.195	0.244
12.10	0.417	0.112	0.240
12.30	0.360	0.086	0.216

1.00 Stomach empty; end of gastric digestion.
Time of digestion = 3 hours and 45 minutes.

X. 9.00 A. M. 50 grams meat + 150 c. c. hochheimer.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.30	0.374	0.140	0.176
10.00	0.432	0.154	0.191
10.15	0.450	0.151	0.198
10.45	0.497	0.187	0.220
11.15	0.533	0.198	0.271
11.30	0.555	0.241	0.227
12.00	0.508	0.248	0.173

12.15 Stomach empty; end of gastric digestion.
Time of digestion = 3 hours and 15 minutes.

XI. 9.00 A. M. 50 grams meat + 50 c. c. whiskey + 50 c. c. water.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.30	0.252	0.101	0.119
10.00	0.392	0.176	0.176
10.30	0.403	0.151	0.191

11.00 Stomach empty; end of gastric digestion.
Time of digestion = 2 hours.

XII. 2.45 P. M. 50 grams meat + 50 c. c. whiskey + 50 c. c. water.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
3.15	0.230	0.076	0.119
3.45	0.320	0.097	0.220
4.15	0.468	0.198	0.212
4.30	0.508	0.198	0.198
4.45	0.490	0.184	0.212
5.15	0.569	0.205	0.252

5.45 Stomach empty; end of gastric digestion.
Time of digestion = 3 hours.

XIII. 1.00 P. M. 50 grams meat + 50 c. c. gin + 25 c. c. water.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
2.00	0.439	0.173	0.194
2.30	0.450	0.170	0.197
2.45	0.428	0.158	0.238
3.00	0.442	0.154	0.212
3.15	0.410	0.140	0.215
3.30	0.420	0.143	0.234
3.45	0.338	0.122	0.180

4.00 Stomach empty; end of gastric digestion.
Time of digestion = 3 hours.

XIV. 9.00 A. M. 50 grams meat + **50 c. c. brandy + 25 c. c. water.**

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.50	0.237	0.159	0.065
10.20	0.368	0.201	0.133
10.50	0.465	0.230	0.205
11.20	0.533	0.267	0.194
11.40	0.468	—	0.158

12.00 Stomach empty; end of gastric digestion.

Time of digestion = **2 hours and 40 minutes.**

XV. 2.50 P. M. 50 grams meat + **150 c. c. lager beer.**

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
3.20	0.259	0.112	0.115
3.50	0.410	0.205	0.148
4.20	0.518	0.245	0.184
4.35	0.572	0.248	0.230
4.50	0.569	0.252	0.208
5.05	0.547	0.220	0.238
5.20	0.508	0.162	0.211
5.35	0.475	0.162	0.238
5.50	0.413	0.115	0.241

6.05 Stomach empty; end of gastric digestion.

Time of digestion = **3 hours and 15 minutes.**

XVI. 9.40 A. M. 50 grams meat + **150 c. c. stout.**

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
10.10	0.364	0.140	0.187
10.40	0.446	0.166	0.180
11.10	0.555	0.220	0.295
11.40	0.616	0.212	0.302
12.10	0.580	0.266	0.247

12.40 Stomach empty; end of gastric digestion.

Time of digestion = **3 hours.**

XVII. 9.15 A. M. 50 grams meat + **150 c. c. beer.**

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.45	0.248	0.151	0.082
10.15	0.367	0.201	0.123
10.45	0.457	0.238	0.137
11.20	0.526	0.266	0.209
11.40	0.511	0.213	0.223
12.15	0.465	0.216	0.176

12.30 Stomach empty, end of gastric digestion.

Time of digestion = **3 hours and 15 minutes.**

XVIIβ. 3.00 P. M. 50 grams meat + 150 c. c. water.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
3.30	0.227	0.130	0.090
4.00	0.400	0.209	0.129
4.30	0.522	0.274	0.158
5.00	0.583	0.310	0.195
5.15	0.583	0.302	0.205
5.30	0.446	0.209	0.184
5.45	0.569	0.298	0.127

6.00 Stomach empty ; end of gastric digestion.
Time of digestion = 3 hours.

XVIIIα. 8.30 A. M. 50 grams meat + 50 c. c. water.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.00	0.371	0.227	0.126
9.30	0.443	0.274	0.144
10.00	0.518	0.252	0.234
10.30	0.569	0.263	0.252

11.00 Stomach empty ; end of gastric digestion.
Time of digestion = 2 hours and 30 minutes.

XVIIIβ. 2.10 P. M. 50 grams meat + 100 c. c. 30 per cent. alcohol

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
2.40	0.234	0.112	0.101
3.10	0.352	0.165	0.137
3.40	0.490	0.209	0.162
4.10	0.550	0.263	0.191
4.40	0.550	0.245	0.201

5.10 Stomach empty ; end of gastric digestion.
Time of digestion = 3 hours.

XIXα. 9.00 A. M. 50 grams meat + 100 c. c. water.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.30	0.324	0.165	0.137
10.00	0.378	0.198	0.144
10.30	0.494	0.259	0.169
11.00	0.487	0.220	0.188
11.15	0.457	0.205	0.131

11.30 Stomach empty ; end of gastric digestion.
Time of digestion = 2 hours and 30 minutes.

XIXβ. 2.30 P. M. 50 grams meat + 150 c. c. lager beer.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
3.00	0.260	0.119	0.137
3.30	0.378	0.201	0.137
4.00	0.465	0.191	0.188
4.30	0.533	0.223	0.248
4.45	0.562	0.233	0.306
5.10	0.465	0.223	0.176

5.30 Stomach empty ; end of gastric digestion.
Time of digestion = 3 hours.

XXα. 9.15 A. M. 50 grams meat + 75 c. c. sherry + 25 c. c. water.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.45	0.295	0.108	0.155
10.15	0.331	0.101	0.173
10.45	0.367	0.133	0.187
11.15	0.418	0.158	0.212
11.30	0.436	0.169	0.216
11.45	0.490	0.191	0.248

12.00 Stomach empty ; end of gastric digestion.
Time of digestion = 2 hours and 45 minutes.

XXβ. 2.30 P. M. 50 grams meat + 150 c. c. carbonated water.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
3.00	0.238	0.043	0.126
3.30	0.360	0.130	0.176
4.00	0.432	0.187	0.169
4.30	0.533	–	0.169

4.45 Stomach empty ; end of gastric digestion.
Time of digestion = 2 hours and 15 minutes.

Dog B. — Weight 21 kilos.

I. 1.45 P. M. 50 grams meat (no water).

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
2.15	0.353	0.191	0.118
2.40	0.443	0.222	0.180
3.00	0.511	0.227	0.198
3.20	0.525	0.227	0.280
3.45	0.572	0.260	0.209
4.15	0.568	0.349	0.195

4.45 Stomach empty ; end of gastric digestion.
Time of digestion = 3 hours.

II. 9.15 A. M. 50 grams meat + 50 c. c. water.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.50	0.302	0.220	0.082
10.15	0.432	0.223	0.144
10.45	0.472	0.201	0.252
11.15	0.472	0.144	0.288
11.35	0.484	0.155	0.270
11.55	0.453	0.144	0.306
12.15	0.407	0.100	0.241
12.30	0.400	0.133	0.234
12.45	0.306	–	0.216

End of gastric digestion.

Time of digestion = 3 hours and 30 minutes.

III. 9.15 A. M. 50 grams meat + 50 c. c. 20 p. c. alcohol + water.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.50	0.136	0.086	0.036
10.15	0.285	0.108	0.144
10.45	0.479	0.173	0.244
11.15	0.472	0.177	0.252
11.35	0.518	0.237	0.252
11.55	0.486	–	0.209
12.15	0.421	–	0.213

12.30 Stomach empty ; end of gastric digestion.

Time of digestion = 3 hours and 15 minutes.

IV. 8.50 A. M. 50 grams meat + 100 c. c. 30 per cent. alcohol.

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.20	0.324	–	0.144
9.50	0.493	–	0.072
10.20	0.641	–	0.100
10.50	0.547	0.338	0.166
11.20	0.588	–	0.206
11.50	0.544	–	0.230
12.20	....	–	present.

12.30 End of gastric digestion.

Time of digestion = 3 hours and 40 minutes.

V. 2.45 P. M. 50 grams meat + **75 c. c. claret.**

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
3.15	0.396	0.155	0.216
3.45	0.450	0.238	0.158
4.15	0.576	–	0.209

4.45 End of gastric digestion.

Time of digestion = **2 hours.**

VI*a*. 9.15 A. M. 50 grams meat + **150 c. c. beer.**

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
9.45	0.273	0.144	0.104
10.15	0.367	0.187	0.155
10.45	0.464	0.223	0.194
11.15	0.616	0.345	0.256
11.45	0.501	0.238	0.170
12.15	0.508	–	0.151
12.30	0.533	–	0.187
12.45	0.468	–	0.158

1.00 End of gastric digestion.

Time of digestion = **3 hours and 45 minutes.**

VIβ. 1.00 P. M. 50 grams meat + **150 c. c. water.**

	Analysis of contents.		
	Total acidity.	Loosely combined HCl.	Free HCl.
2.00	0.620	0.282	0.201
2.30	0.590	0.266	0.234
3.00	0.666	0.392	0.224
3.30	0.627	–	0.206
4.00	–	–	trace.

4.15 End of gastric digestion.

Time of digestion = **3 hours and 15 minutes.**

In the accompanying table the "time of digestion" of the experiments preceding is given in hours. The experiments marked α and β are strictly comparable, as reference to the protocols will show that they were carried out in succession on the same day.

TABLE OF TIME OF DIGESTION (IN HOURS).

Dog A.					Dog B.			
No.	Water.	Alcohol.	Weak alcoholic beverages.	Strong alcoholic beverages.	No.	Water.	Alcohol.	Weak alcoholic beverages.
	h. m.	h. m.	h. m.	h. m.		h. m.	h. m.	h. m.
XVII α	....	....	3 15	....				
XVII β	3	....	....	....	I	3	....	....
I	2 55	....	....	....	II	3 30	....	....
II	2 20	....	....	....	III	....	3 15	....
VII	....	3	....	....	IV	....	3 40	....
VI	....	3 30	....	....	V	....	....	2
VIII	....	3 05	....	....	VI α	....	....	3 45
IX	....	3 45	....	....	VI β	3 15	....	....
XVIII α	2 30	....	....	....		....	....	....
XVIII β	....	3	....	....		....	....	....
XIV	....	....	....	2 40		....	....	....
XV	....	....	3 15	....		....	....	....
XIX α	2 30	....	....	....		....	....	....
XIX β	....	....	3	....		....	....	....
XVI	....	....	3	....		....	....	....
IV	2 30	....	....	....		....	....	....
X	....	....	3 15	....		....	....	....
III	3	....	....	....		....	....	....
XIII	....	....	....	3		....	....	....
XX α	....	....	....	2 45		....	....	....
XX β	2 15	....	....	....		....	....	....
V	2 40	....	....	....		....	....	....
XI	....	....	....	2		....	....	....
XII	....	....	...	3		....	....	....
Average	2 40	3 20	3 10	2 40		3 15	3 30	2 52

From these results it is apparent that the time of digestion in the stomach for the proteid test meal employed is not greatly varied under the influence of alcohol. The results obtained suggest, possibly, a tendency toward prolongation of the period during which the meat remains in the stomach when alcoholic fluids are present. This tendency is most noticeable in the case of Dog A, and particularly in those experiments which immediately succeed each other on the same day and are therefore strictly comparable. These differences are too small, however, to have any great significance, especially as in Dog B weak alcohol appears to have increased the rate of digestion, and in Dog A strong alcohol did not cause any lengthening of the average time of digestion. Retardation is perhaps more marked with the malted beverages and is apparently out of proportion to the alcohol present. With reference to the

changes in the acidity of the stomach contents, a large number of observations disclose no specific differences in the various digestions. The variations are common to all the experiments. They include a gradual rise in total acidity during approximately the first two hours of digestion, followed by a gradual decrease until the stomach becomes empty: at this point free HCl is absent. The combined HCl increases with the progress of digestion, the products of proteolysis combining with relatively larger quantities of free acid.[1] Since the secretion of acid is continually progressing in the stomach, the percentage of free HCl increases gradually in the course of the digestion, likewise decreasing rapidly toward the end of this process. In agreement with our previous statements relative to the rather sudden discharge of the gastric contents into the intestine (p. 285), an abrupt decline in acidity toward the end of the digestion period was frequently observed. Evidence of an "after period" of secretion was not obtained.[2]

D. DISAPPEARANCE OF ALCOHOL FROM THE STOMACH.

It has long been known that alcohol disappears rapidly from the alimentary canal, and even so early as 1847 Bouchardat and Sandras stated that the absorption takes place from the stomach especially.[3] More recent and conclusive experiments, in which the pylorus has been artificially closed, have demonstrated with certainty that alcohol, in distinction from water, is readily absorbed from the stomach.[4] Furthermore, many substances, like sugar, peptone, etc., are readily absorbed from the stomach in the presence of alcohol, while their absorption from the intestine is likewise accelerated by this substance.[5] Thus, an ordinary dose of chloral hydrate introduced in watery solution into a stomach with ligated pylorus fails to bring about

[1] Cf. Chittenden, *Digestive Proteolysis*, 1894, pp. 53 *seq.*

[2] Cf. Gluzinski, *Jahresbericht f. Thierchemie*, 1886, xvi. p. 264.

[3] Bouchardat and Sandras, *Annales de chimie et de physique*, 1847, xxi. 3 série, p. 456.

[4] Cf. for example, Tappeiner, *Zeitschr. f. Biologie*, 1881, xvi. p. 497; Brandl, *Ibid.*, 1892, xxix. p. 277; v. Mering, *Jahresbericht f. Thierchemie*, 1893, xxiii. p. 293.

[5] Cf., for example, J. v. Scanzoni, *Zeitschr. f. Biologie*, 1896, xxxiii. p. 462.

narcosis;[1] if, however, a quantity of alcohol too small of itself to produce any pharmacological action be present, narcosis follows, just as when the open pylorus permits the intestine to participate in the absorption.

The complete disappearance of alcohol from the stomach has been observed by us in a large number of experiments in which the pylorus was ligated. The following results, tabulated from the experiments on secretion (pp. 269–276), demonstrate this statement: —

Table showing Absorption of Alcohol from Stomach.

No.	Weight of dog. Kilos.	Duration of experiment.	Volume of fluid introduced. c. c.	Content of alcohol. Per cent. by vol.	Alcohol found at end of experiment. Grams.
		h. m.			
VII	23.0	3 30	200 (alcohol)	37.5	4
VIII	21.0	3 00	200 (")	37.5	4–5
IX	8.0	3 50	100 (")	5.0	0
X	7.3	3 45	110 (")	4.8	0
XIII	10.7	3 55	75 (sherry)	21.0	0
XIV	18.5	3 45	150 (whiskey)	16.0	0
XV	8.0	3 45	125 (wine)	13.3	0
XVI	25.0	3 00	135 (")	13.3	0
XVII	12.3	4 00	125 (claret)	5.15	0
XVIII	10.2	3 55	100 (beer)	4.5	0
XX	14.0	3 45	150 (porter)	3.75	0
XXI	8.5	3 55	125 (beer)	4.7	0

The rapid discharge of watery or alcoholic fluids from the stomach through the pylorus has already been referred to on p. 284. The results are in harmony with those obtained by v. Mering on dogs with duodenal fistulæ.[2] In his experiments, for example, 500 c. c. being administered to a large dog, 490 c. c. were expelled through the pylorus in twenty minutes. The rapidity of expulsion was found to depend on the state of repletion of the small intestine, — an observation in accord with the retarded evacuation of the stomach seen when food is given along with fluids. v. Mering further observed that when water holding CO_2 in solution enters the stomach the gas is readily absorbed:[3] alcohol is likewise absorbed, as J. Miller

[1] Cf. also experiments with strychnine. Meltzer, *Journ. of Exper. Medicine*, 1896, i. p. 529.

[2] v. Mering; quoted in Gamgee, *Physiological Chemistry*, 1893, ii. pp. 441 *seq.*

[3] Cf. also Experiment V., p. 286.

has recently verified for the human stomach.[1] Ogáta[2] found that of 6.5 to 8.8 grams of alcohol introduced into the stomach in wine or beer, 80 to 90 per cent. disappeared within half an hour. In the presence of soluble products in the stomach an excretion of water by that organ is said to result in proportion to the amount of substance absorbed, — an idea akin to the one suggested in explanation of the relatively larger quantities of fluid found in the unligated stomach soon after introduction of alcohol, as compared with water. The experiments which we have made verify the statements of the investigators mentioned, as the following data, selected from protocols, indicate: —

Data showing disappearance of alcohol from unligated stomach.

I. Dog, with gastric fistula.

a. 3.45 P. M. Introduced 50 c. c. 20 per cent. alcohol into stomach.
4.15 " Removed gastric contents = 40 c. c. No alcohol found.

b. 3.15 " Introduced 40 c. c. 25 per cent. alcohol.
3.45 " Removed gastric contents = 20 c. c. No alcohol found.

c. 2.40 " Introduced 125 c. c. 20 per cent. alcohol.
3.10 " Removed a portion of gastric contents. Free HCl = 0.072 per cent. Small amount of alcohol present.

II. Dog of 18 kilos, employed in a salivary experiment. In the course of the latter the animal received at intervals 45 c. c. absolute alcohol diluted with water. Two hours after last portion was given the stomach contents (200 c. c.) were removed. They contained 1.1 grams alcohol.

III. Dog of 18 kilos. Salivary experiment. At intervals were given 70 c. c. absolute alcohol diluted with water. One and one third hours after last portion (40 c. c.) was given the stomach contents (350 c. c.) contained 9.4 grams alcohol.

IV. Dog of 14 kilos. Salivary experiment. 140 c. c. absolute alcohol diluted with water were given in three portions. Three fourths of an hour after the last portion (50 c. c.) the stomach contents (450 c. c.) contained 24.6 grams alcohol.

V. Dog of 10 kilos. Salivary experiment. 120 c. c. whiskey, containing 50 per cent. of alcohol, were given in two portions. Four and one half hours after the last portion (60 c. c.) the stomach contents (170 c. c.) contained 2.7 grams alcohol.

VI. Dog. Salivary experiment. 135 c. c. brandy, containing about 50 per cent. of alcohol, were given in two portions. Two hours after last portion (75 c. c.) the stomach contents (240 c. c.) contained 8.8 grams alcohol.

[1] Miller, J., *Arch. f. Verdauungskrankh.*, i. p. 233. *Jahresbericht f. Thierchemie*, 1895, xxv. p. 293.

[2] Ogáta, *Jahresbericht f. Thierchemie*, 1885, xv. p. 274.

VII. Dog of 10 kilos. Salivary experiment. 350 c. c. wine, containing 5.15 per cent. of alcohol, were given in two portions. One and one half hours after last portion (200 c. c.) the stomach contents (190 c. c.) contained 5.5 grams alcohol.

It is of interest to note that the large volumes of fluid (170 to 450 c. c.) found in the stomach in Experiments II. to VII. correspond with the data already presented with reference to the increased secretion of gastric juice due to alcohol and alcoholic beverages.

E. SUMMARY.

Some of the more important conclusions to be drawn from these series of experiments may be advantageously summarized here.

Upon the secretion of saliva the presence of strong alcohol or an alcoholic beverage in the mouth has a direct stimulating effect leading to a sudden increase in the flow of saliva. This acceleration of secretion, however, is of brief duration. The stimulating effect is manifested not only by an increase in the volume of the secretion, but also by an increase in both organic and inorganic constituents. The effect produced is in no sense peculiar to alcohol, but is common to many so-called stimulants, such as dilute acid (vinegar), ether vapor, etc. Indeed, the effect is precisely analogous to that induced by an increase in intensity of stimulation when the salivary glands are electrically excited through their nerves.

As to the possibility of alcoholic fluids absorbed from the stomach giving rise to an indirect stimulation of salivary secretion or exercising any appreciable influence upon the composition of the secretion, our results give a negative answer. Thus, alcoholic fluids introduced directly into the stomach (of dogs) by injection through the stomach wall, thus doing away with any local action in the mouth, produce no appreciable effect upon the rate of secretion, as induced by a constant external stimulus, of either submaxillary or sublingual saliva. Even doses of alcohol sufficient to produce prolonged narcosis when introduced in this way fail to check the flow of saliva. There is likewise no specific influence exerted on the composition of the secretion. Hence, so far as our results go, alcohol and alcoholic fluids are without any specific effect upon the secretion of saliva, except to produce a transitory stimulation of secretion while in the mouth cavity.

Upon gastric secretion alcohol and alcoholic fluids have a marked effect, increasing very greatly both the flow of gastric juice and also its content of acid and total solids. Further, this action is exerted not only by the presence of alcoholic fluids in the stomach, but also indirectly through the influence of alcohol absorbed from the intestine. Thus, ordinary ethyl alcohol introduced into the empty stomachs of dogs, with the duodenum ligated, shows a marked stimulating action upon gastric secretion — as compared with the action of water under like conditions — increasing not only the volume of gastric juice very greatly, but also its acidity, content of solid matter, etc. Moreover, alcohol absorbed from the intestine, the latter being entirely shut off from the stomach, may likewise cause stimulation of the gastric glands, with a marked increase in the rate of secretion, etc. Whiskey, brandy, sherry, claret, beer, and porter all agree in producing stimulation of gastric secretion. Further, as already stated, the gastric juice secreted under alcoholic stimulation is more acid, contains more solid matter and more combined hydrochloric acid than the ordinary secretion. It is likewise strongly proteolytic.

If these results are considered in connection with our previous observations upon the influence of alcohol and alcoholic drinks upon the purely chemical processes of gastric digestion, it is seen that side by side with the greater or lesser retardation of digestive proteolysis caused by alcoholic beverages there occurs an increased flow of gastric juice rich in acid and of unquestionable digestive power. The two effects may thus normally counterbalance each other, though it is evident that modifying conditions may readily retard or stimulate the processes in the stomach according to circumstances. Foremost among the latter is the rapid disappearance of alcohol from the alimentary canal.

Since any influence exerted by alcohol or alcoholic beverages upon the solvent or digestive power of the gastric juice in the stomach must depend upon the presence of alcohol in the stomach contents, it follows that the tendency toward rapid removal of the alcohol from the alimentary tract by absorption must necessarily diminish correspondingly the extent of any retardation of gastric digestion which the presence of alcohol in the stomach may occasion. Since, however, the stimulation of gas-

tric secretion induced by alcohol is brought about not only by the direct action of alcohol in the stomach, but also by the indirect action of alcohol absorbed from the intestine, it follows that possible inhibition of the digestive action of the gastric juice would probably be of shorter duration than the stimulation of secretion, and that consequently in the body alcoholic fluids would hardly lead to any retardation of gastric digestion. This point has been very carefully and thoroughly tested by numerous experiments on healthy dogs with gastric fistulæ, using proteid test meals, with the result that certainly in the stomach of dogs digestion is not retarded in any pronounced degree under the influence of alcohol or alcoholic fluids. Of hastened digestion the results obtained give little or no positive suggestion, and we must therefore conclude that the two diverse factors above referred to more or less counterbalance each other, so that gastric digestion in the broadest sense of the term is not markedly varied under the influence of alcohol or alcoholic fluids. This conclusion, it may be mentioned, stands in perfect harmony with the results of the investigations of Zuntz and Magnus-Levy regarding the influence of alcohol (beer) on the digestibility and utilization of food in the body. These investigators found by a series of metabolic experiments on men with diets largely made up of milk and bread, and on individuals accustomed and unaccustomed to the use of alcoholic beverages, that the latter did not in any way diminish the utilization of the food by the body.[1]

Especially worthy of note is the rapid disappearance of alcohol from the stomach and alimentary tract when alcoholic fluids are taken. As our results show, the introduction of even 200 c. c. of thirty-seven per cent. alcohol into the stomach of a dog, with the duodenum ligated at the pylorus, may be followed by the nearly complete disappearance of the alcohol in three to three and one half hours by absorption through the stomach walls into the blood. With the outlet from the stomach into the intestine open the rate of absorption of alcohol is greatly increased. We may well believe, as stated by Ogáta, that

[1] Zuntz and Magnus-Levy, *Archiv f. d. ges. Physiol.*, 1891, xlix. p. 438; Magnus-Levy, *Ibid.*, 1893, liii. p. 544.

when six to eight grams of alcohol are taken into the stomach in the form of wine or beer eighty to ninety per cent. of the alcohol will disappear from the alimentary tract inside of half an hour. Indeed, our own experiments on dogs with gastric fistulæ lead to this conclusion. Thus, in one experiment 50 c. c. of twenty per cent. alcohol were introduced into the stomach, and on withdrawing the stomach contents half an hour later no alcohol whatever was found in the 40 c. c. of fluid obtained. In view of this rapid disappearance of alcohol from the alimentary tract it is plain that alcoholic fluids cannot have much, if any, direct influence upon the secretion of either pancreatic or intestinal juice.

3. The Influence of Alcoholic Fluids on the Composition and Amlolytic Power of Human Saliva.[1]

In this series of experiments the attempt was made to ascertain how far alcoholic fluids, acting as stimuli to secretion, will modify the properties of mixed saliva. The special agents employed were ether, alcohol, whiskey, and gin. The first two were taken into the mouth in the form of vapor, and the saliva allowed to trickle from the mouth without motion of the jaws, the fluid so obtained being compared with saliva resulting from the mechanical stimulation produced by chewing a piece of rubber. With whiskey and gin, the mouth was well rinsed with the fluid and the saliva collected by allowing it to flow from the corner of the mouth. The control experiments with water were made in the same way; i. e., the mouth was rinsed with water and the saliva allowed to trickle forth. Finally, for the sake of comparison and to ascertain how far two samples of saliva obtained at such close intervals, under similar forms of stimulation, differ from each other, four control experiments were tried with water and rubber alone.

Following are the results obtained: —

[1] The experiments here reported were originally published by R. H. Chittenden and Alfred N. Richards in the *American Journal of Physiology*, i. 461, 1898.

Date.	Time.	Stimulus.	Volume saliva c. c.	Alkalinity calculated as Na_2CO_3. Per cent.	Amylolytic power. Milligrams maltose.	Total solids. Per cent.	Organic matter. Per cent.	Inorganic salts. Per cent.
	A. M.							
Dec. 3	11.05–11.30	Rubber	40	0.168	582.6	0.03	0.31	0.32
	11.30–11.50	Ether	30	0.204	624.6	0.76	0.54	0.22
" 9	9.50–10.10	Rubber	30	–	562.8	0.54	0.30	0.24
	10.10–10.30	Ether	25	–	498.6	0.54	0.29	0.31
" 13	11.40–12.00	Rubber	40	0.122	472.2	0.41	0.21	0.20
P. M.	12.00–12.35	Alcohol	28	0.132	510.6	0.43	0.19	0.24
	A. M.							
" 14	10.00–10.30	Water	30	0.061	473.4	0.32	0.19	0.13
	10.30–11.00	Whiskey	35	0.102	485.4	0.42	0.29	0.13
" 16	10.15–10.40	Water	23	0.071	483.6	0.34	0.20	0.14
	10.45–11.20	Gin	24	0.102	642.0	0.53	0.36	0.17
" 17	10.20–10.38	Ether	27	0.122	586.2	0.32	0.16	0.16
	10.45–10.55	Rubber	28	0.183	577.2	0.52	0.24	0.28
" 20	11.15–11.48	Water	24	0.071	606.6	0.68	0.55	0.13
P. M.	12.15–12.45	Water	24	0.102	564.0	0.38	0.27	0.11
Jan. 11	3.03– 3.35	Water	26	0.053	436.8	0.30	0.16	0.14
	4.05– 4.40	Water	30	0.081	532.2	0.35	0.21	0.14
	A. M.							
" 13	11.25–11.40	Rubber	30	0.153	571.8	0.49	0.26	0.23
P. M.	12.10–12.26	Rubber	30	0.261	550.8	0.47	0.24	0.23
	A. M.							
" 14	10.38–10.58	Rubber	34	0.132	577.8	0.50	0.27	0.23
	11.30–11.45	Rubber	32	0.142	594.6	0.51	0.26	0.25

A glance through these results shows at once certain marked differences in the character of the saliva obtained under the different conditions specified. Thus, saliva which flows from the mouth after the latter has been rinsed once with water invariably shows a lower degree of alkalinity and generally contains a smaller percentage of solid matter than the secretion obtained by the other methods. In amylolytic power, however, there is great variation, some samples showing a relatively strong amylolytic action, while others with essentially the same degree of alkalinity are much weaker in their starch-digesting power. Simple mastication of rubber has a marked influence in raising the content of alkaline salts in the saliva, as well as the total inorganic constituents, and there is a tendency toward increase in amylolytic power, although the latter is not constant.

As to the influence of alcohol, ether, gin, and whiskey, there is, we think, no question that these agents taken into the mouth change the character of the secretion, increasing its alkalinity, amylolytic power, and content of solid matter. This is certainly true if the secretion so obtained is compared with the saliva flowing from the mouth without stimulation of any kind. Saliva, however, secreted under the stimulation produced by chewing rubber, is, as we have seen, comparatively concentrated, and the difference between the secretion resulting from that method and the fluid coming from ether, alcohol, and other like forms of excitation, without mechanical stimulation, is not so decisive in the above experiments as to make the matter quite clear, especially in view of the fact that two portions of saliva obtained one after the other, by the same method of stimulation, are liable to show marked differences in composition and reaction. Particularly noteworthy is the fact that of two portions of saliva collected one after the other by mechanical stimulation (chewing rubber) or by simply allowing the saliva to flow from the mouth after once rinsing the latter with water, the latter portion of saliva is, as a rule, more concentrated and possessed of higher amylolytic power than the portion first secreted. It is thus obvious that great care must be exercised in drawing deductions from the composition and amylolytic action of mixed saliva when the latter is so prone to vary under what seem to be essentially the same forms of stimulation. It is furthermore equally obvious that the possible causes to which the above variations may be attributed are many, since there are involved three distinct sets of glands in addition to the buccal glands of the mouth cavity. Hence, increase or decrease in amylolytic power, as well as in the general concentration of the secretion, may involve simply an alteration in the relative activity of the individual glands and not be connected primarily with any specific stimulation of metabolic or secretory activity.

However this may be, it is quite clear that the natural variations in the character of the mixed saliva, indicated by the results of the last four experiments of the above series, render it necessary to use great caution in arranging the conditions under which the experiments are tried. We have therefore repeated the above experiments, choosing for the collection of

the saliva a time of day when we have found the mixed saliva most constant in composition; viz., between 9.30 and 10.30 A. M. To be sure, there are variations in the composition and starch-digesting power of successive portions of saliva collected by the same method at this period, but they are relatively small; quite small, indeed, as compared with the variations liable to occur at other periods of the day. The truth of this statement is illustrated by the two following experiments, in which the saliva was collected without stimulation, simply allowing it to flow from the mouth.

Date.	Time.	Volume saliva. c. c.	Alkalinity as Na_2CO_3. Per cent.	Amylolytic power. Milligrams maltose.	Total solids. Per cent.	Organic constituents. Per cent.	Inorganic salts. Per cent.
	A. M.						
Feb. 3	9.32–10.06	21.0	0.0816	569.4	0.50	0.31	0.19
" 3	10.15–10.42	22.0	0.0918	549.0	0.46	0.29	0.17
	P. M.						
" 3	5.00– 5.20	19.5	0.0918	573.6	0.49	0.31	0.18
" 3	5.27– 5.50	17.0	0.1122	613.8	0.68	0.51	0.17

Thus, the two portions collected between 9 32 and 10.42 A. M. are essentially alike, while the two fractions secreted between 5.00 and 5.50 P. M., all without stimulation, are more dissimilar. Adopting the morning hour as the better time for collection, experiments were tried with alcohol, ether, chloroform, whiskey, and gin, comparing in each case the saliva obtained under their influence with the secretion coming without stimulation of any kind. The exact method pursued in the case of the control, i. e., with water, was to rinse the mouth once with distilled water, after which the saliva was simply allowed to drop from the mouth into a beaker. With ether and chloroform the mouth was filled once with the vapor and the saliva then allowed to flow spontaneously into a receptacle without any motion of the jaws. With the alcohol, gin, and whiskey, 10 c. c. of the fluid were taken into the mouth, held a moment, and then ejected, after which the saliva was collected as in the other cases. Lastly, an experiment was tried (February 15) by chewing

rubber as a stimulant and comparing the saliva so obtained with a control secreted without stimulation. Following are the results obtained : —

Date.	Time.	Stimulus.	Vol. saliva. c. c.	Alkalinity as Na_2CO_3. Per cent.	Amylolytic power. Milligrams maltose.	Total solids. Per cent.	Organic constituents. Per cent.	Inorganic salts. Per cent.
	A. M.							
Feb. 7	10.05–10.32	Water	18.0	0.0714	480.6	0.42	0.22	0.20
	10.37–10.56	40 % Alcohol	18.0	0.1122	514.2	0.43	0.26	0.17
" 8	9.37–10.05	Water	18.0	0.0612	566.4	0.42	0.25	0.17
	10.11–10.32	Ether	18.0	0.1122	558.6	0.54	0.29	0.25
" 10	9.53–10.18	Water	17.5	0.0816	601.2	0.51	0.33	0.18
	10.27–10.47	Chloroform	17.0	0.0714	644.4	0.69	0.48	0.21
" 11	9.40–10.07	Water	17.0	0.0714	493.3	0.39	0.25	0.14
	10.14–10.36	Whiskey	17.0	0.1020	547.8	0.50	0.31	0.19
" 15	9.52–10.16	Water	16.5	0.0816	541.2	0.38	0.21	0.17
	10.21–10.27	Rubber	17.0	0.1530	577.2	0.58	0.26	0.32
" 18	9.33–10.03	Water	17.0	0.0714	584.4	0.49	0.33	0.16
	10.10–10.34	Gin	19.0	0.1020	610.2	0.57	0.39	0.18
" 23	9.26– 9.51	Water	17.0	0.0714	429.6	0.30	0.18	0.12
	10.01–10.24	Water	17.5	0.0714	423.0	0.31	0.18	0.13

From these results it would seem quite clear that the several agents employed, with the exception of chloroform, give rise to a marked increase in the content of alkaline-reacting salts in mixed saliva. Mechanical stimulation, as by chewing rubber, however, is even more effective than the chemical stimuli employed, although it must not be overlooked that in the above experiments the action of alcohol, ether, whiskey, etc., is necessarily of short duration. Further, there is evidence in most of the results of an increase in amylolytic power, as well as in the content of solid matter under the influence of the stimuli. It is thus safe to assert that alcohol and alcoholic fluids not only stimulate the flow of saliva, but that they also tend to increase the concentration and amylolytic power of human mixed saliva, — results which are in close accord with the action of these fluids upon the secretion of the sub-maxillary saliva of the dog.

DATA RELATING TO THE USE OF ALCOHOLIC DRINKS AMONG BRAIN WORKERS IN THE UNITED STATES.

BY

J. S. BILLINGS, M. D.

DATA RELATING TO THE USE OF ALCOHOLIC DRINKS AMONG BRAIN WORKERS IN THE UNITED STATES.

Early in 1895 a circular letter of inquiry was sent to about 1500 men in the United States engaged in mental work of a high class. The list included the leading members of the legal, medical, and clerical professions, distinguished scientific men and educators, prominent business men, and managers of great corporations. To this circular 892 replies were received, and the data from these replies have been compiled in the following tables.

An attempt was made to obtain returns from physicians with regard to the habit of use of alcoholic drinks and its effects upon the health of families under their charge, but the results were of little value. The records of 230 persons were received, of whom 31 per cent. were affected with chronic disease. The proportion thus affected was for the total abstainers 11.6 per cent. and for the moderate drinkers 31.5 per cent. Nearly all of the returns came from a few physicians who are prominent advocates of total abstinence.

There is no great difficulty in obtaining opinions of physicians as to the effect of the use of alcoholic liquors; but when it comes to filling out forms for each one of their patients, there are very few who are willing to take the trouble to do this.

Dr. Robert T. Edes, of Jamaica Plain, Mass., kindly placed at the disposal of the Committee a number of reports received from the Massachusetts State Board of Health, Lunacy, and Charity, in connection with an inquiry sent out to physicians of that State in 1879 with regard to hereditary effects of the use of alcohol. These reports have never been collated. Dr. Edes stated that the facts were too few and too vague to be of value, and nothing was done with them.

The following tables indicate the minimum proportion of users of alcoholic drinks among successful brain workers in this

country. The total abstainers and moderate drinkers probably reported in greater proportion than the regular drinkers.

It will be seen that the percentage of total abstainers was lowest among the physicians (1.4 per cent.), and highest among the clergymen (54 per cent.), and that the percentage of regular drinkers was greatest among the business men (26.5 per cent.).

Of the total abstainers 10.3 per cent. reported themselves as affected with indigestion, acute rheumatism, or nervous disease of some kind. Of the occasional drinkers 6.8 per cent. report themselves as thus affected, and of the regular moderate drinkers 9.2 per cent. report as being thus affected. The regular moderate drinkers used mainly claret and light wines: the occasional drinkers used chiefly whiskey and beer.

As regards the percentage of those reporting themselves as being in bad health, it should be remembered: —

1. That the opinions of persons as to their own health have little scientific value.

2. That those who know that they are affected with serious chronic disease were less likely to furnish reports than those who believed themselves to be sound.

3. That the questions were sent chiefly to men known to be actively engaged in their professions or business and not broken down by ill health.

4. That the physical and mental qualities which tend to make a man specially successful in professional or business life include a more than ordinary power of resistance to various agents which may injure health.

TABLE SHOWING BY STATES THE NUMBER OF TOTAL ABSTAINERS, OCCASIONAL DRINKERS, AND REGULAR MODERATE DRINKERS AMONG MEN ENGAGED IN BRAIN WORK WHO REPORTED AS TO THEIR HABITS IN THE USE OF ALCOHOLIC DRINKS, WITH DISTINCTION OF AGE.

States.	Total.	Total Abstainers.						Occasional Drinkers.						Regular Moderate Drinkers.					
		Total.	Ages.					Total.	Ages.					Total.	Ages.				
			Under 45	45–55	55–65	65–75	75+		Under 45	45–55	55–65	65–75	75+		Under 45	45–55	55–65	65–75	75+
Canada	1	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–
Maine	5	4	2	–	2	–	–	1	–	1	–	–	–	–	–	–	–	–	–
New Hampshire	6	2	–	–	1	1	–	4	2	1	1	–	–	–	–	–	–	–	–
Vermont	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Massachusetts	429	95	13	37	17	18	10	282	99	96	52	28	7	52	18	17	12	4	1
Rhode Island	10	2	–	1	–	1	–	7	–	3	3	1	–	1	1	–	–	–	–
Connecticut	49	3	1	1	–	–	1	40	7	17	10	4	2	6	3	–	1	2	–
New York	71	9	2	1	5	–	1	34	10	13	8	1	2	28	5	9	10	2	2
New Jersey	15	2	1	–	1	–	–	9	2	4	3	–	–	4	–	2	1	1	–
Pennsylvania	27	5	–	–	5	–	–	18	1	8	6	1	2	4	1	1	2	–	–
Delaware	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Maryland	21	5	–	1	2	2	–	12	–	7	3	–	2	4	1	1	1	–	1
District of Columbia	160	15	2	3	7	3	–	112	22	40	35	13	2	33	7	8	13	5	–
Virginia	2	–	–	–	–	–	–	2	1	1	–	–	–	–	–	–	–	–	–
South Carolina	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1
Georgia	1	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–
Kentucky	1	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–
Louisiana	11	–	–	–	–	–	–	9	2	3	2	1	1	2	–	1	1	–	–
Michigan	2	1	–	–	–	1	–	1	–	1	–	–	–	–	–	–	–	–	–
Ohio	39	13	2	4	5	1	1	20	4	9	6	1	–	6	–	1	1	2	2
Illinois	5	3	2	–	–	–	1	2	–	2	–	–	–	–	–	–	–	–	–
Wisconsin	5	1	–	1	–	–	–	3	2	1	–	–	–	1	1	–	–	–	–
Minnesota	4	2	1	1	–	–	–	2	1	–	1	–	–	–	–	–	–	–	–
Iowa	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Missouri	19	1	–	1	–	–	–	15	1	9	4	1	–	3	1	1	1	–	–
Montana	1	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–
Utah	1	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–
California	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–
Oregon	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tokyo, Japan	1	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–
	892	167	28	53	45	27	14	579	175	219	136	51	18	146	38	42	43	16	7

TABLE SHOWING BY OCCUPATION THE NUMBER OF TOTAL ABSTAINERS, OCCASIONAL DRINKERS, AND REGULAR MODERATE DRINKERS.

Occupations.	Total.	Total Abstainers.						Occasional Drinkers.						Regular Moderate Drinkers.					
		Total.	Ages.					Total.	Ages.					Total.	Ages.				
			Under 45	45-55	55-65	65-75	75+		Under 45	45-55	55-65	65-75	75+		Under 45	45-55	55-65	65-75	75+
Legal	22.7% 204	7.3% 15	2	4	6	3	-	71.6% 146	54	43	37	12	-	21.1% 43	14	14	10	3	2
Clergymen (not teachers) . . .	17.0% 152	54.0% 82	12	25	18	16	11	43.4% 66	17	23	12	7	7	2.6% 4	1	-	2	1	-
Professors and Teachers . . .	14.8% 132	21.9% 29	9	11	6	2	1	67.4% 89	21	40	22	4	2	10.6% 14	4	3	4	3	-
Physicians . . .	16.2% 145	1.4% 2	-	2	-	-	-	83.4% 121	39	52	20	8	2	15.1% 22	6	8	5	3	-
Army and Navy .	3.4% 30	10.% 3	-	-	3	-	-	80.% 24	3	8	9	4	-	10.% 3	-	-	3	-	-
Business Men . .	16.5% 147	19.7% 29	5	10	8	4	2	53.7% 79	10	29	22	12	6	26.5% 39	7	11	13	4	4
Others	9.2% 82	8.5% 7	-	1	4	2	-	65.8% 54	11	24	16	2	1	25.6% 21	6	6	6	2	1
Aggregates.	892	18.7% 167	28	53	45	27	14	64.9% 579	155	219	138	49	18	16.3% 146	38	42	43	16	7
Sick	110	17	4	3	5	4	1	62	9	22	23	7	1	21	3	6	9	2	1
		102 per 1000						107 per 1000						144 per 1000					

Table showing the Percentages of Total Abstainers, Occasional Drinkers, and Regular Moderate Drinkers of the Total reporting for each Occupation.

Occupations.	Total.	Total Abstainers.		Occasional Drinkers.		Regular Moderate Drinkers.	
		Total Cases.	Percentage.	Total Cases.	Percentage.	Total Cases.	Percentage.
Legal	204	15	7.3	146	71.6	43	21.1
Clergymen (not teachers) .	152	82	54.	66	43.4	4	2.6
Professors and Teachers . .	132	29	21.9	89	67.4	14	10.6
Physicians	145	2	1.4	121	83.4	22	15.1
Army and Navy	30	3	10.	24	80.	3	10.
Business Men	147	29	19.7	79	53.7	39	26.5
Others	82	7	8.5	54	65.8	21	25.6
Aggregates	892	167	18.7 of total cases.	579	64.9 of total cases.	146	16.3 of total cases.

Many of the persons furnishing the reports, from which the above tables were derived, added remarks, and a number of these are given herewith. They represent all shades of opinion, but in general agree that the use of alcoholic drinks as a stimulus to mental effort gives bad results, although they may be agreeable as restoratives in fatigue.

Group I. Remarks of Lawyers and Judges.

No. 1. I was accustomed in earlier life to see all wines used very freely. I was led to think it as necessary or usual as a clean shirt. At about forty-five I was a very hard worker, and quite used up at times. Sir Henry Thompson suggested to me to let all wine alone, absolutely. For one or two years I drank *nothing* — I now rarely do — but drink daily, for form's sake, a wineglass of Scotch whiskey and soda or seltzer water at dinner.

I am an excellent judge of what is good in wine, and have perhaps an exceptional taste. I do not miss wine at all. I am enormously better without it. I would not miss the use of

Scotch whiskey. I think from this I suffer no harm. It is not in any way necessary.

No. 2. I believe I have never been under the influence of liquor, but I should not advise any one to follow my methods of life. Temperament and constitutional conditions enter so largely into the question that it has seemed to me that the consumer should be licensed to drink according to his capacity and not the dealer. In army and professional life I have seen more evil result than good from the occasional or rational use of liquor.

No. 3. Before reaching my fifty-fourth year I drank wine freely at dinner and was in the habit of taking one and sometimes two drinks of whiskey just before going to bed. Since giving up whiskey, seven years ago, there has been a decided improvement in my health, and every addition to the two glasses of claret affects me unfavorably. My best judgment is that the omission of the claret also affects me unfavorably.

No. 4. I keep my physical and mental activity always on the strain. Find a half bottle of wine slightly stimulating for a very short time, but invigorating for a longer period. Am satisfied that wine is useful as a food for body and for mind, if the quantity is properly graduated.

No. 5. For a person with a touch of alcoholism, either inherited or acquired, nothing less than total abstinence is safe. Alcoholism strongly hereditary — almost never acquired by use of light, still wines only — usually by spirits or champagne. Moderate use of alcoholic liquors generally safe for persons having no hereditary tendency. After fifty, very beneficial. Men under thirty better without it.

No. 6. From personal experience I should say that drink ruins more men than any other form of indulgence. The constant aim should be to restrict the use of alcoholic drinks as much as possible by legislation that is regulative rather than prohibitory. Social customs that are calculated to cultivate a taste for strong drink should be corrected. Light wines taken at meals are at times beneficial, but ardent spirits should not be drunk on such occasion or any other.

No. 7. I believe (in the U. S.) total abstinence in youth, followed (upon attaining manhood) with reasonable indulgence in stimulants, is not harmful; that those who are much in the open

air are least apt to be injured by stimulants; a reasonable amount of wine (if pure) of the type generally known as claret, I believe to be wholesome, and commend its use; mental exertion should never follow any use of stimulant: the work may be well and quickly done, but the waste is too great; the atmosphere of the United States is itself rather stimulating and promotive of nervous troubles and excitement, — a reason for slight use of stimulants. On the other hand, in certain parts of the country a condition of climate exists called "malarious" colloquially, which is enervating and depressing; where this condition exists more spirits can be used safely (and perhaps advantageously) than in a strong, cool, and bracing climate. On the whole, I believe the use of honest beer and wine in moderation is wholesome; the use of spirits is dangerous from its tendency, but a moderate amount is not harmful — what is a moderate amount is difficult to define. The great danger in the use of spirits is the tendency to gradually increase the amount as the system becomes accustomed to the stimulant.

No. 8. In administering the federal law in the criminal courts for twelve years I have been amazed to find how many crimes can be traced directly or indirectly to drink. For this, spirits — whiskey — is chiefly responsible. Here and in England drunkenness is common and repulsive. I cannot recall ever having seen a drunken man or woman in France. I attribute this to the fact that in France the use of light wines is the rule and the use of spirits the exception. If the use of light wines were encouraged here by the abolition of high tariff duties, and otherwise, it is certain that the use of whiskey would decrease. No man, certainly no hearty man, requires whiskey. One who uses it habitually is unfitted for any mental work. He is utterly unfitted for any position of trust. He is a useless and, often, a dangerous member of society.

Until some more radical improvement is possible, and I fear that day is far distant, I would have reformers work along the line of substituting light and comparatively harmless stimulants for the "fire-water" which is the principal root of the evil of intemperance.

No. 9. Am convinced that a moderate amount of whiskey, or gin, claret, or good ale at or after dinner each day is helpful, aiding digestion, taking away all desire to drink water while

eating, and apparently answering a natural desire for a limited amount of alcohol, which taken in this way does not seem to increase. Such a regular and moderate consumption I believe is conducive to the health of the majority of men working and living as such majority do. Especially do I believe this true in the case of those whose vocations necessitate habitual intellectual work.

No. 10. I drink when occasion offers, but have no craving for alcohol. I think I have a slight tendency to inflammation of the stomach, and that habitual drinking of spirits, and perhaps wines, would be injurious, and for this reason think the habitual use would be distasteful.

I smoke, and drink coffee to an extent that would kill most men, but without visible injury. I think smoking has a tendency to make a man lazy and contented with things as they are, and thus has its good and bad side. Coffee is to me a most agreeable stimulant, and never followed by depression; tea would injure me more than rum.

No. 11. I think a moderate use of light wines and beers is conducive to health, and helps one to keep up his strength in time of need, and by driving out heavy liquors would tend to promote temperance. The evils to health and society are, I believe, almost wholly caused by the use of distilled liquors.

No. 12. I do not profess to be an expert or to have much knowledge on the problem under investigation, but my impression is that the occasional use of spirits is not injurious to one's physical health. Of course habitual use or excess at any time is injurious, but for a man of sedentary habits, I think an occasional stimulant is an advantage. My impression is that if I did not have children I would have a wine, claret, for instance, on my table every day at dinner: but as a matter of precaution in connection with their training I do not have. I have never myself been under the influence of liquor that I know of in my life, and think I am but a type of a very large number of men in my sphere of life. I am quite clear that such use as I have made of liquor has been beneficial.

No. 13. From observation I conclude that a majority of men over forty-five years old, who can digest spirits, wine, or beer, are benefited by the moderate use of either of these articles. Of course there can be no universal rule as to what quantity

will be beneficial. I am also willing to believe that the use of drink by those under forty-five is not, on the whole, detrimental.

No. 14. For a long time I, habitually, took a drink or two between breakfast and dinner, usually whiskey, and generally without eating. I became satisfied that this practice was injurious, producing dyspepsia, and impairing working capacity. The claret and water which I now drink at dinner seems to go to the right place, but I am satisfied that stronger liquor would do me no good. With the exception of yellow fever, in 1867, and dengue in 1880, I have never been sick.

No. 15. From my personal experience should say that, aside from the matter of sociability, it would have been better for me, enjoying good health, not to have drunk at all, and my advice to the young would be not to begin to use alcoholic drinks in any form.

No. 16. I was never intoxicated in the slightest degree in my life. I can, and occasionally do, at a club dinner, drink more than most men, and know that I feel it less. Before I have any effects from drinking my stomach rebels and rejects its contents. This has happened to me three times. On each occasion I was very tired, and had eaten extravagantly as well as drunk a great deal.

From my observation, I am sure of one thing. There are many men who are strangely affected by one drink. After one drink they seem to lose all control of themselves and proceed to get drunk. These are generally men of weak physical vitality. Drink ruins them physically and mentally. After drinking it is some time before they recover their normal condition, and that is bad. Such men should never drink at all. Among the men of good general physical condition with whom I associate, I should say that ninety per cent. were moderate drinkers, and that not ten per cent. of these are at all injured by it.

No. 17. I think moderate drinking not injurious. I think as one grows older he desires wine less and needs it more. I have never drank enough to be able to describe the effects of drink.

No. 18. I believe that a man of ordinary health is not benefited by the use of liquors when under forty-five years of age. I believe that the proper use of liquors as a general thing is the

very best form of stimulant that has yet been discovered; and that the abuse of such stimulant is the worst thing in the world; and that no kind of prohibitory law can or will reach the evil.

No. 19. I have chronic dyspepsia which has tormented me for years. I carry around a little hell. I have found the regular consumption of whiskey in very moderate amounts of enormous value to me. It has tided me over a thousand seasons of pain and left no ill effects or weakness. Beer I cannot touch, nor was I ever able to drink it regularly. When I was younger I drank moderately various kinds of wine, but found I had to give up one after another, and have come to the conclusion that the safest and best drink is Scotch whiskey. I believe that if I were to give up its use my health would suffer materially.

No. 20. I believe that the daily use of spirits, wine, or beer is neither necessary nor beneficial to any man in a good normal condition of health. I believe in their use only to a limited extent as a social function and for their medicinal effect.

No. 21. I never knew any person in health who was not injuriously affected to a greater or less extent by the daily use of spirits, wine, or beer, except old persons, to whom it is in many cases of benefit when taken in moderation.

My observation has been somewhat extensive, my personal experience limited, although I am not a teetotaler. The result of both is that the regular consumption of a moderate quantity of whiskey, wine, or beer is not conducive to the maintenance of the health and working power of any class of men, at least until the effect of old age begins to be felt: that occasionally each is useful as a stimulant, but that all other use tends to diminish the health and working power of all classes of men.

I do not think that the average man in good health, in this country, may consume daily any quantity of whiskey, wine, or beer without more or less risk of eventually injuring his health: because the constant use of any stimulant soon brings the system into an abnormal condition, and no man in an abnormal condition can be properly said to be in good health. He is only in good health so long as his natural vitality and vigor suffice, without artificial reinforcement, for the demands which his daily life makes upon him, at least until his powers are affected by his age.

No. 22. I cannot find that the consumption of a moderate quantity of whiskey, beer, or wine either helps or hurts the health. In case of physical exhaustion or mental languor I do not doubt that a moderate amount of spirits has a stimulating and beneficial effect.

No. 23. Speaking generally, find abstinence better for physical condition than daily drinking would be. Find occasional use of wine, beer, and spirits beneficial, e. g. contrast a dinner party without wines with one where wine is served.

No. 24. My own disposition is against the regular daily use of drink. From my own limited experience I should say that after forty or forty-five years of age an occasional use of stimulant for a properly balanced man is promotive of health. I question whether the "working power" of a man is increased one atom by drink, except as it may preserve general health.

I deprecate its use "as a social function" as inducing most people to use it before their decreasing powers indicate its need. I think the loose American habit of "treating" responsible for a great deal of useless drinking.

No. 25. If spirits and wine could be always used in small and temperate quantities, there would be, probably, no evil results; but the use of either, and of beer, is dangerous for young people. I regard the social punch-bowl as the source of much intemperance. The moderate use of spirits and wine, especially the latter, after one has reached the age of forty or fifty, I regard as wholesome and harmless.

No. 26. Do not believe that the use of spirits, etc., is necessary to the maintenance of health, or conduces thereto, except in rare cases.

Believe that the quantity of spirits, etc., which a man in good health may consume daily without injury to health, depends upon climate and occupation, and much less upon age, except in the case of the very young and very old. Do not believe stimulants should be used during the "growing age."

No. 27. I consider the moderate use of whiskey now beneficial to me; but have always found the constant use of beer, ale, and especially porter, injurious to my digestive organs.

I believe the excessive use of ardent spirits so injurious to the community that laws restrictive of liquor selling are advisable.

No. 28. Think moderate use of beer, wine, or liquor, not

injurious, depending on a man's physique, in some cases decidedly beneficial.

No. 29. My mind never works as actively or as clearly, either in my profession or in any matter of practical every-day judgment, after partaking, however slightly, of any alcoholic drink. Having a natural tendency to stoutness, beer makes me heavy and sleepy, and I accordingly avoid it wholly, except occasionally in very cold weather when I am going to get plenty of exercise after it, as in walking or skating. I enjoy good wines occasionally at dinner in the evening, but I always feel the next day as if I had lost a little ground which I must make up, and I do so in twenty-four hours; but I would not on any account drink wine every day or habitually. I don't believe in it at all, although I am confident that I possess full self-control against any excess; but I should n't care to risk the gradual and imperceptible loss which I think must come with habitual use.

No. 30. My opinion is that a nervous man who is a brain worker should be a total abstainer. I regard any man as in danger who drinks spirits for the sake of the exhilaration.

No. 31. For twenty years nearly I have taken a little ordinary table claret at my dinner, and I think it has been of service to me. Could all drinking of that which may intoxicate be limited to our dining, and as moderate as my use has been, I think health would be promoted and no evil effects result.

No. 32. As a general rule, I do not believe that the regular consumption of a moderate quantity of whiskey, wine, or beer is conducive to the maintenance of health and working power in any class of men. To this general rule, however, I think there are individual exceptions.

Group II. Remarks of Physicians.

No. 1. The experience of over twenty-five years as a physician has firmly convinced me that active men, who from habit, inclination, or force of circumstances take but a light morning and noon meal and a hearty dinner at night may take wine or spirit of moderate amount with their dinner without injurious effects, and, probably, with benefit in some cases.

Except as above stated, I do not think the daily use of spirit fails to injure the average man. A glass of sherry (one ounce) or claret (two ounces) or beer (one pint) may be taken with dinner by most men without noticeable injury.

No. 2. Twenty-five years of observation of "Life Risks" leads me to think that the habitual daily use of undiluted spirits (whiskey) impairs longevity. Total abstainers, who have formerly indulged to excess, are poor risks. A very moderate, temperate use of light wines, or diluted spirits, especially after the age of fifty-five, is more conducive to longevity than is total abstinence, so far as I am able to judge.

No. 3. I find equal parts of Rhine wine and seltzer water "agrees" with me better than either tea or coffee for luncheon, "a very light meal."

Professionally I find many men, who cannot use spirits or beer without digestive disturbance, can use light white sour wines diluted with some alkaline mineral water with actual benefit. I prescribe them for such cases when there is no "moral hazard" of forming a habit.

I believe no healthy man under fifty needs any form of alcohol habitually. Many healthy men under fifty can use it daily in moderation (say Anstie's limit) without damage to their tissues, but without physical or mental benefit. The unfavorable results of this form of indulgence may appear in their children.

I have no question that many men under fifty are injured by the habitual use of alcohol (always in moderation). I have seen many cases of dyspepsia and lithæmia undoubtedly caused by its use, and in many constitutions it predisposes to cardio-vascular changes, premature atheroma and its consequences.

I may add that I doubt if the habit of over-indulgence is likely to be acquired in the class of cases above mentioned, for the reason that the alcohol is usually taken with meals; hence no immediate and acutely stimulating effect on the nervous system is produced.

No. 4. I have commencing cardiac and aortic degeneration, which has been a very common cause of death among my relatives.

I am better in body, mind, and disposition, when I use alcohol in moderation. Those who live with me are as much convinced of this fact as I am. I was several years ago led to the use of liquor above described by the advice of the well known total abstainer, Dr. B. W. Richardson, of London. Were it not for my recognized obligation, as a member of the Church Temperance Society, to use only the smallest quantity of alcohol that I

need, I should take at least once daily, at meal-time, the equivalent of from one to two glasses of sherry. I have no question that my bodily health would be in every way improved, and I may yet decide to do this.

Individuals who are strong and well in body and mind are better without any alcohol. The enfeebled of either sex, without distinction of years, are often greatly helped by using it in connection with food, under competent and conscientious medical guidance. It is, however, impossible to say this truthfully, unless at the same moment one insists upon the constant risk to health and self-control which goes with any transgressing of these medical limits. Thus, I have often known in urgent disease, the so-called "heroic" employment of alcohol to be indispensable to the saving of life; and yet in certain instances as soon as the illness disappeared even the smallest use of this agent did harm.

Further, the duty which weighs upon all medical advisers to insist as rigidly upon the abandonment of alcohol when health is restored, as to enjoin a resort to it in time of need, well shows the extreme difficulty of replying to this inquiry in any way but conditionally. In like manner, in the case of young persons, with habits of life still unformed, the beneficial and necessary employment of stimulants involves extreme risks, which can never be disregarded.

Alcoholic stimulants taken in place of food, or rather to avoid eating, are wholly to be condemned. Used with food they are beneficial just so far as they, like condiments, salt, pepper, spices, improve the digestion (in the full medical sense) of the individual. In every instance the smallest quantity that will produce that result is to be distinctly preferred. It is then impossible to fix a uniform safe standard, as the second question seems to demand.

The same rules apply here as in every other permitted indulgence of the body: less rather than more; constant effort at self-control: if the body is to be profited: temperate use, not uncompromising refusal.

No. 5. In Germany I drank a glass of beer every day at dinner, at home here I drank occasionally at a public dinner or with a guest at home a glass of wine, for say fifteen or twenty years. For perhaps five to ten years I took a drink of whiskey on going to

bed that I might secure sleep at once. I think I began to feel effects from it in an excitable condition of the heart. I found also that I could not work so well, became easier fatigued, had less inclination to work. I found also that alcohol in any form stimulated the use of tobacco, which encouraged languor and dreamy indolent states. So I quit both absolutely three years ago, and have been better, brighter, and stronger ever since, with nearly double working capacity.

No. 6. I believe fermented drinks are unnecessary in ordinary life; they do not give real strength or endurance; that many may use these moderately without any deleterious effect on shortening of life I fully believe; but many on the other hand demonstrate the evil effects. They are a most expensive luxury, which people of moderate means should not indulge in.

I believe that people who do hard but outdoor work can far better resist the bad effects on the health than those of sedentary habits.

No. 7. The less alcoholic drinks taken, the better. If a stimulant is needed, black coffee or tea are the best. The constitution of the drinker has perhaps more to do with the effects, near and remote, than the quantity taken. Example has more to do with the habit than a really great desire.

Food of good quality and quantity, properly cooked and appetizing, is the best stimulant for work; alcoholic drinks are but the lash to the horse.

No. 8. I believe that my distaste for strong liquor is hereditary. All my ancestors are Catalonians and have been very sober, frugal, and industrious. I have known of no habitual drunkard in my immediate family either on the paternal or maternal side. I have never felt that wine or alcohol in any shape was necessary for my physical or intellectual welfare. I enjoy the fragrant bouquet of the French liqueurs (Bénédictine, Chartreuse, etc.) and the sweet wines of southern Spain (Malaga, Alicante, etc.), but merely after a social gathering at table. On such occasions the contagion of example and the stimulus of conviviality adds greatly to the inherent qualities of the wine, and to the pleasure of its use.

I am convinced from personal experience that the regular consumption of even a moderate quantity of whiskey, wine, or beer is not necessary to the maintenance of health and working

power in any class of men; and that even the moderate but habitual indulgence in the stronger liquors (whiskey, brandy, gin, and rum) is injurious to health.

I consider that heredity and environment are most important determining factors in the problem; and under the head of environment I would especially refer to the notable neurasthenic tendencies that are being progressively manifested by the most civilized races under the strain and friction of the conditions of our present civilization.

No. 9. When exhausted by over mental work stimulants seem to revive without doing me harm. I have never used them prior to mental work and do not know what effect on it they would have. I think four ounces of whiskey would be beneficial rather than harmful to a man able to control appetite. In old age I believe four to six ounces of whiskey daily decidedly beneficial. I oppose the use of stimulants before the age of thirty-five, and always forbid it to nervous people who are very susceptible.

No. 10. I find it desirable to keep my organism absolutely free from alcohol, whenever I intend to do hard mental work. On the whole, I feel best, more vigorous, and am in better spirits when I totally abstain. I also sleep better, but on the other hand, occasional attacks of sleeplessness are easily overcome by alcohol (beer). It looks as if I am drifting towards total abstinence.

No. 11. I had a long siege of septicæmia with glandular infection and rheumatism. Used whiskey, three or four ounces daily, with few exceptions, for many weeks with apparent benefit; certainly it added to my comfort. I have for ten years used occasionally, when very tired or exhausted by special labor, whiskey (or wine), in moderate quantity, with benefit. I rarely get much fatigued, and have worked very hard for many years.

I think stimulants affect most favorably men of middle age who have been temperate in their youth.

No. 12. My personal observation, experience, and convictions are that the custom of treating at the bar, and the existence of liquor saloons are responsible for three fourths of the excessive use of liquor. There is no difficulty in tracing the downward course of many men in this city of high education who first be-

came victims of the drink habit through invitations to the bar and acquiescence in the system of treating.

No. 13. There can be no questioning, I think, the fact that the daily habitual use of alcoholic drinks predisposes to chronic gastritis and diseases of the liver and kidneys.

No. 14. My father, a lawyer in large practice and of indefatigable industry, was accustomed to take about two thirds of a bottle of port wine every day (he was an Englishman). He drank three or four glasses with dinner and the remainder before going to bed. He retired from practice in his 76th year, and died in his 91st year of mere age.

Moderation, not abstinence, and the best quality of wines, etc., had much to do with this happy condition.

No. 15. Many men after fifty are benefited by the moderate use of alcoholic liquid, not exceeding two ounces of alcohol daily; but no one is free from danger of excess, and, therefore, its continuous use is always dangerous. Have known many habitual consumers to excess daily, and especially at night (night-caps) who have lived to advanced age in apparent perfect and vigorous health. They were habitual consumers who never exceeded a certain amount — but always took that amount.

No. 16. From my experience during a very active life of twenty-six years of medical practice, I have reached the conclusion that the regular consumption of a moderate or even small quantity of whiskey, wine, or beer is not conducive to the most perfect health or the highest working power in my profession or in any walk in life. In the conditions of life in cities, I believe the most effective work is performed by total abstainers from alcohol, but that the greatest harm is done to men of sedentary pursuits, and to those who through the stimulus of alcohol consume a larger quantity of nitrogenous food than they would otherwise take. It is in these cases that lithæmia is produced with its many attendant functional disturbances. Leaving out of consideration all the harm done by alcohol in excess, the injury done by moderate regular indulgence is incalculable. Almost all the ill health in men beyond forty is associated with alcoholic indulgence and with imprudent or excessive eating in association with it. Chronic interstitial nephritis, a disease very frequently met with, is almost in

every instance the direct result of these antecedents. A man who leads an active outdoor life may consume with impunity a limited quantity (three or four glasses of claret as a maximum, or two ounces of whiskey), but he is all the worse for the habit so far as his working capacity is concerned. Beyond sixty years, and in a northern or cool climate, such indulgence is attended with much less chance of injury; but in all ages and in all climates alcohol is in my opinion not conducive to, does not aid in producing, the most perfect health. A man is in perfect health in spite of, and not by the help of, alcoholic drinks.

Group III. Remarks of Clergymen.

No. 1. I have taken a light wine, claret or hock, continuously for months, and then desisted for as long, or a longer period, because my system seemed not to require it, — or even to resent it. I have taken beer in the evening before retiring, similarly for a period of some months, and then desisted as having no desire for it. It is quite the exception for me to take either beer or wine. I have found that a little good whiskey diluted with water, taken before retiring, conduces to sleep, when I am working hard, and seems to have no ill effect. The last I think better than wine or American beer, but I have no fixed habit in the matter, and without inconvenience abstain entirely, except that if I abstain entirely while working hard and late at night I am not likely to sleep well. I have a singularly healthy and sensitive constitution; a slight increase of whiskey will give me headache: but from two to four tablespoonfuls (the maximum quantity) can be taken with impunity and with the result of giving me sleep.

No. 2. The result with me is increasing doubt of the value of habitual daily use of any stimulant, and increasing conviction of the value of occasional use.

No. 3. From what I have seen I believe that men who use stimulants sparingly are in better health than those who are abstainers.

No. 4. My belief, based solely on personal experience, is that temperate use of stimulants is a good thing. I find no growing taste, nor increasing demand for liquor. Family always have used liquor temperately — no drunkards known in it for several generations.

No. 5. From personal experience of thirty-five years in the pastorate, the drink habit, in any degree, from beginning to end, is a curse, and in some member of the household of the poor is responsible for a large share of poverty as it confronts church benevolence.

No. 6. When my two sons were ten years old I was confronted with the question of what I should teach them on this question. I desired to teach them both by precept and example that judgment which I believed to be upon the whole the safest. Should I teach them "total abstinence?" or "temperance?" There is peril either way. I chose temperance as the lesser of the two dangers. I think the result has vindicated my decision.

As a clergyman I have avoided the position of a "total abstainer," because I have found that men who are in danger from drink will listen to me when they know that I am a reasonable man, and will not so readily allow themselves to be remonstrated with by a total abstainer.

No. 7. My experience goes to show that after overwork, or when digestion is disturbed by irregular hours, a moderate amount of spirit is a restorative and a sleep producer. I experience only good results from this practice.

No. 8. Never saw any good to bodily health, mental vigor, or moral development from the use of alcoholic liquors; but on the contrary have seen a great deal of injury to body, mind, and moral nature by its use.

No. 9. It is my candid conviction, from my experience, that no one to my knowledge has ever received any permanent gain to health, if even temporary relief from pain, by the use of alcoholic drinks. It has proved destructive to all whom I know as habitual drinkers. I feel that it is no great credit to me that I am a total abstainer since I have never had the least inclination to drink, the smell of rum or beer rather nauseating me.

Group IV. Remarks of Scientific Men, Teachers, Business Men, and Others.

No. 1. My own experience would indicate that the moderate use of alcoholic beverages of various kinds may be occasionally beneficial, though I have always seriously doubted whether or not the temporary stimulus was not succeeded by a correspond-

ing reaction. I am of the opinion that much depends on the individual idiosyncracy, and on the conditions of life and the climate. I have never felt better than when indulging moderately in such beverages with the people who habitually so indulge, and during the time when I was leading an outdoor life. I am inclined to believe that indoor life and especially sedentary habits and mental occupation make it necessary to be very frugal in the use of such alcoholic beverages: and that the indirect effect of the alcoholic habit, when it becomes a necessity, altogether offsets any temporary benefit that may otherwise accrue to the moderate drinker.

No. 2. My conclusion from my observation is that whiskey is one of the best drugs in the pharmacopœia and one of the most dangerous beverages ever discovered or used. Malt liquors are excellent tonics in convalescence. The habit of drinking them surely leads to excess. In my own experience the use of liquor has never done much good or harm, except in convalescence, when it has benefited me. It has not done my constitution any permanent injury. Its moral effects are injurious. It leads to indiscreet words and acts. With certain persons it not only unbalances the judgment, but produces a homicidal tendency and other criminal tendencies.

Nearly all the crime in the South has its origin in whiskey. So much am I convinced of this that if the enforcement of prohibitory laws was possible I would strenuously advocate them. With us much good is effected by local option. Unless the negroes can be rescued from the abuse of whiskey, their lot will become intolerable.

No. 3. My experience as a mining man has satisfied me that while good liquors are very valuable medicines and should always be obtainable, their habitual use, even in strict moderation, by working men is a mistake. I have not found that alcohol increases working power, physical or mental. When I had to make sudden demands upon men for heavy, uninterrupted work of long duration, such as can occur in breakdowns of machinery, fires, etc., I have given plenty of tea or coffee or soup during the work, but no alcohol until the job was finished. Thus given it is very beneficial, as it gets the system over the "dead centre" when, as the men express it, "they are too tired to eat."

I am strongly in favor of a rigid but intelligent restriction of the liquor traffic. Where this has existed, either by law or circumstances, I have had little difficulty in practically abolishing drunkenness among my men, not only during working hours, but also during the nights of the week, although liquor could always be obtained. Even on Sundays and holidays the amount of drunkenness was rarely very serious. Never allowed liquor to be sold on my land, and in this, as in all other measures for repressing drinking, had always the full support of my men, who were a rough set of whites and negroes, some of them ex-convicts, some notorious ruffians when drunk.

No. 4. My observation leads me to believe that any one is unfortunate who contracts a habit of regular drinking, even if it be moderate. I believe the constant use of beer to be injurious to health; but not so with a very moderate use of pure wines. I think the use of distilled liquors always dangerous, but in very moderate quantities not injurious to health. I do not believe in prohibitory laws, but in teaching and practicing temperance.

No. 5. I never found that it helped me at all towards doing work to drink at the time. I cannot speak or write as well after taking even a moderate amount of alcoholic liquors or wines. What I take I do for my general condition. My digestion has improved markedly since I exchanged claret (which had come to produce flatulency) for Scotch whiskey. After severe exposure I should always take stimulants to prevent cold or undue depression: but not to do work upon. With food I thoroughly believe in a moderate amount of wines or other stimulant for all persons at least who are past the period of superabundant activity. As to taking things at night I have my doubts; but I do it for myself because I like it, and because I am well and hearty under that system.

No. 6. From my observation both in Europe (Belgium, France (Germany more especially), I have come to the conclusion that moderate drinking of light wines and beer is not conducive to intemperance.

No. 7. Alcoholic stimulants, whatever their nature, must invariably, and in any quantity, affect the brain more or less favorably or unfavorably, according to the condition of the partaker. Sometimes one glass of beer will affect me unpleasantly,

at other times I may drink four to six and feel the better for it bodily and mentally. Sometimes wine stimulates my brain power to greater activity; at other times it incapacitates me for mental work. I have known men who needed the stimulus to accomplish certain mental exertion. The momentary condition and disposition of bodily and mental functions modifies the effect.

If I may briefly add my views from the ethical and legislative point, I consider the moderate use of stimulants (i. e. light wines and beers) as legitimate enjoyments of life, just as music and art, coffee and cigars, candy and cake.

Abstinence from fear of excess argues a defective moral power which should be educated, or else of bodily disease; abstinence from lack of enjoyment shows defective development of capacities to enjoy.

As to legislative action, I believe in restriction or rather regulation of the liquor traffic on the same principle as powder magazines, etc., are regulated; this alone is really practicable, education must do the rest: prohibition only leads to other immoralities.

No. 8. I find that during the winter months, when I am occupied in office work, a moderate use of stimulants is pleasant, and I fancy useful in promoting digestion. On the other hand, when in the field (and I have spent an unusually large part of my life in hard camp life, mountain climbing, etc., often involving great physical hardship) I need no stimulants, and I believe, from comparing my own experience with that of others engaged in similar life at the time, I am stronger and better without the stimulant. I have proved by actual experience that in a long exposure without food, and other hardships, one occasionally goes through in western exploration, that I could endure more in the long run than men who had spent their entire lives in that kind of work, but who thought stimulants necessary, and used them freely. I believe if man could live a perfect simple country life he would be better without any stimulant of any kind; but that city life and the nerve strain that accompanies it is better endured with the help of a moderate use of stimulant: but I also believe that such stimulation exhausts the vital force so much the quicker. The quantity that can be taken without harm varies with individual temperament.

No. 9. Never drink water other than the so-called mineral or soda waters. Always feel better for some stimulant. Never took much alcoholic stimulant till I was thirty years of age, and never drank to excess. Feel better in health for moderate use of alcohol, and think it aids digestion when taken at meal-time.

No. 10. I would not be willing to have the habit of drinking any spirituous liquor, even at my dinner table, so as to feel the want of it. But I agree with Matthew Arnold, that, inasmuch as a glass or two of wine at table is agreeable to me, prompts cheerfulness, and adds a little to the enjoyment of life, I find no harm in it. Occasionally, perhaps once in a month or two, when not likely to go at once to sleep from having something on my mind, I take half a small wineglass of whiskey in twice as much water, with a biscuit, just before going to bed. This I find almost invariably gives me a good night's rest. But I am not sure that I feel quite as well.

No. 11. I never drink before dinner, and I dine at seven. I think drinking at lunch, or at any time before dinner, is injurious to most men. If I am going to work on my books in the evening, a glass of sherry is quite enough. Drinking spirits and water, after an evening spent in study, induces me to sleep, and my sleep is, and has always been, good. I think rye whiskey agrees perhaps better with me than any other spirit. Beer does not seem to agree with me in winter.

No. 12. Before the age of forty-one I spent some years in explorations and surveys in the western United States, and had charge of men and assistants. The men of most endurance were either total abstainers or not habitual users of either fermented or distilled liquors; and now twenty-five (to thirty-four) years after, all the known survivors are those who were then either total abstainers or only occasional users.

No. 13. I should have had no scruple against using wine, etc., had I believed it useful to me, though much opposed to its common use as a beverage; and finding no need for it, I have abstained for the public good. My observation of effect of drinking goes decidedly against its daily social use. As a college officer I learned to dread its injurious effects on students. It invariably hurt those who drank habitually.

No. 14. My personal experience and observation have taught

me that the consumption of a moderate quantity of wine, whiskey, or beer is not conducive to the maintenance of health in any class of men. It is impossible to determine the amount of these which may be taken daily without risk. It is not uncommon to see a robust man show the effect of an ordinary glass of whiskey, while I know a gentleman not robust, who weighs but 124 pounds, who can comfortably dispose of a bottle of it. In this city (Washington) I feel the effect of a half an ounce of whiskey. In Boston, I can take two ounces without feeling it. So I can at sea. In Washington, a bottle of Bass's ale I feel the effect of. At sea, or in London, I can take four with comfort. Climate and occupation are undoubtedly large factors.

No. 15. All heavy drinkers who began life with me are under the sod. Moderate, but constant, drinkers are older, in effect, than I am; they are suffering with some ailment. To this statement I would make two exceptions, and these men are remarkable for their fine constitutions; I look at them daily with wonder because they drink so much.

No. 16. For forty-five years it has been my work to control and direct men, often by hundreds, sometimes by thousands. More than nine tenths of all the difficulties encountered have arisen from the use of intoxicating drinks, alike in civil life and in army life. These difficulties began in managing men on a farm when I was a youth and still continued in directing scientific research.

No. 17. The facts regarding excessive drinking are plain; it is a menace to health, happiness, character, and life of the individual, and to the welfare of society. Moderate drinking has, within my experience, led to excessive drinking in so many cases that I regard the latter a natural sequence, and those cases in which the habit is held in moderation to be exceptional, though not rare. In such cases, the force of example in generating impulses that are not restrained seems to me a sufficient reason for the abandonment of moderation in drinking in favor of total abstinence.

No. 18. Believe that whiskey, wine, and beer help nobody when good water is to be had. It is a question of no damage, or how much damage is done. I have observed that men who bathe much, exercise much, and perspire much, drink heavily with the least apparent damage. The English gentleman, for

example, is oftentimes the picture of health and energy even when he is a heavy drinker. The American habit of desultory drinking is harmful in high degree. The English habit of drinking in routine with eating, bathing, and exercise, is much less harmful. Men of sedentary habits should not drink at all. Believe total abstinence impracticable of attainment, but repressive measures under the law advisable. Respectable classes should be taught how to drink reasonably.

No. 19. The general conclusion drawn from observation and experience is that during all of earlier and middle life, while a man is in the full vigor of health, any form of vinous or alcoholic stimulant is unnecessary, and hence to a greater or less degree injurious, except during periods of extraordinary physical and mental exertion especially accompanied by deprivation of sleep. In such cases, sometimes extending as many as from twenty-four to thirty-six hours, some stimulants during the latter part of the term of exertion have been found indispensable. Later in life when the digestion becomes less vigorous and the physical strength somewhat impaired, my experience leads me to believe that a small quantity of dry wine or good whiskey with dinner is desirable, but that any form of stimulant, except in case of great fatigue or great exhaustion, is decidedly injurious. Perhaps the most remarkable fact in my own experience is that almost the only time when rheumatic pains are wholly absent is when the blood is flowing vigorously under the influence of a reasonable quantity of good whiskey, and I do not discover that there is any injurious after effect, provided the stimulant is taken with considerable food, or following it, during the process of digestion and not upon an empty stomach.

No. 20. I believe that the moderate use of a light claret has helped me to avoid difficulties of digestion more than anything else I have tried. I should state that my diet has always been very light and simple by preference as well as prudence. I have come to believe that the universality of the dyspeptic and nervous troubles, so characteristic of the over-worked professional man in America, is very largely due to the reluctance to use a light stimulant in later life, a custom which, whatever its moral bearings, is universal in other civilized countries.

No. 21. Young men who drink are in danger of contracting habits which destroy their business, social, and religious useful-

ness. I always discriminate against a regular drinker in extending credit; so do all banks, insurance companies, railroad companies, and corporations generally. The consumption of whiskey, wine, or beer is not necessary, and leads to crime. Introduce the sale of liquor where it is not sold, and you will at once increase crime. Men who want to have clear heads, pure hearts, and prosper in the community want to avoid habitual drinking.

No. 22. No argument whatever can convince me that liquor is required in the world, and to wipe it out entirely would do more for Christianity, and to create a *gigantic real estate* sale of hospitals and prisons, than everything else combined.

No. 23. It is within my personal experience that men engaged in clerical work give the best satisfaction who do not indulge in spirits of any kind.

No. 24. After a life of extraordinary vicissitudes and extremes, physical and mental, my repeatedly tested conclusion is this: —

Wine and distilled spirits may be taken beneficially in limited quantities and for a limited time, viz.: after extraordinary exposure; after extraordinary fatigue; after debilitating illness; during a period of prostration; but the use must not be sufficient to disturb or excite the system and cannot be continued long without injurious effects and a dependence of the system upon the stimulant. And I deem the use more injurious and dangerous for brain workers than for any other class of persons.

But there has come within my observation a fact which is worth more for the Committee of Fifty than a thousand individual experiences: —

During the war I was a prisoner for thirteen months in Louisiana and Texas. Among the prisoners were many men, soldiers and sailors, but chiefly sailors who had been addicted to drink. For four or five months the conditions of life were fairly sanitary. On the one hand the prisoners were in roomy, well ventilated barracks; they had to police and keep clean their quarters and grounds under their own officers, acting with the coöperation of the Confederate authorities; they had sufficient food and sufficient means for cooking it properly; they had saved their clothes when captured; they were allowed to go out and cut their own wood; they were marched across Texas from Hempstead to

Shreveport, and from Shreveport back to Tyler. On the other hand there was the confinement and depression of imprisonment, the lack of regular work: a climate they were not accustomed to, and some malarial influences. Notwithstanding the latter conditions these men improved physically and mentally in such a marked degree that other officers agreed with me, at the time, that enforced total abstinence was the very best condition that could be imposed upon them.

And in confirmation of the above, I repeatedly observed that many of these men, after they had returned to their homes with all the advantages of civilized life, had run down and did not appear either physically or mentally to be as fair specimens of manhood as they did while inmates of a Confederate prison camp.

But here I must specially guard what I have above stated, by saying that those observations must be confined to the period of four or five months of fairly sanitary conditions. I do not mean to say that the filth and squalor and starvation and nakedness and wretchedness which attended a considerable part of their captivity showed any favorable result whatever.

No. 25. From a large experience with drinking men in a line of work for their rescue, covering many years, I find that the drink habit is one that they have formed not through predisposition, but during the years of eighteen to twenty-four from so-called good-fellowship and treating: then, having acquired a habit, and their system craving alcohol, it became the old story of an uncontrollable appetite. This applies to the millionaires, and the sons of the same — who have the means to gratify their wants, and do so till their systems refuse, when mania-a-potu and death follows, as well as to the gutter-snipe who burns for rum, and dies the death of a neglected drunkard. Rum levels them both and affects them in the same way — here and hereafter. The curse is in the abuse, but the man, as a rule who is abusing the use of it, does not consider that it applies to himself, but to the other fellow, and will sympathize, and sometimes remonstrate with him in his being a slave to drink.

No. 26. I do not believe the regular consumption of whiskey, wine, beer, etc., is conducive to health, etc., but I am satisfied it is always attended with danger arising from gradual physical dependence upon stimulant.

No. 27. Believe myself benefited of late years by the occasional very moderate use of alcoholic stimulants taken either with dinner or before retiring when physically depressed. On the whole, approve of total abstinence up to forty or forty-five years of age; after that believe that the moderate use of stimulants is often beneficial.

No. 28. During the war I was captured and held a prisoner for six months in Libby, Macon, Charleston, and Columbia. Insufficient and improper food produced a serious disarrangement of the digestion and left me with a tendency to a catarrhal condition of the stomach, bowels, and bladder, which became chronic later through overwork and nervous strain, which have been continuous through life, resulting in occasional breakdowns and long absences for recovery. Five years ago, on one of these occasions, while crossing in a N. G. Lloyd steamer, I was led to try a little Mosel wine. It comforted my stomach and assisted digestion and assimilation. Its continued use produced such marked and favorable results that I have continued it to this day, and am absolutely sure that to it is due a complete recovery of my digestion, and the disappearance of catarrh, except from grip or a cold, which yields as in other cases. *Used only with food* none of the things I take tend in the slightest degree to create an appetite. If it becomes necessary to go without anything, I do not miss it unless I go so long that the tendency to a catarrh begins to assert itself; then I have the beginnings of indigestion; but there is not the slightest cravings for a stimulant.

Few men endure more constant strain than myself.

Taken merely as a stimulant and on an empty stomach any form of alcohol has rather a narcotic, not a stimulating effect. It does not assist mental action, and after a little, perceptibly diminishes it, even in small quantity.

No. 29. The use of whiskey in moderation has not seemed to be deleterious: on some conditions of the mental and physical system it has been a decided benefit.

No. 30. I believe that we should encourage light native wines or beer as a beverage for the classes. Should be glad to see American wine sold as cheaply and used as freely as in Continental countries and all heavy liquors banished if possible. Heavy liquors cannot be healthy in our climate as a

steady drink. Englishmen and Scotchmen who in this country keep up their habits of drinking brandy as freely as at home generally become drunkards. I have made this a matter of careful observation; I lived in England for nine years.

No. 31. My own observation, both in Europe and America, leads me to the conclusion that the use of wine in moderate amount at table is entirely harmless, and frequently beneficial; that the tippling habit at the saloon or bar or club is always dangerous, and frequently destructive.

No. 32. My opinion is that the habitual or even occasional use of spirits is always injurious. That the very moderate use of wine or beer may not be injurious if kept within moderate limits, but is always attended with more or less danger of leading to excess: that it is always dangerous for a woman to drink at all; that it is dangerous for a man to drink until his habits and character are fairly formed: that it is dangerous to drink before and during work: that the reformation of a confirmed drunkard, either a periodical or a constant drinker to excess, is very rare.

No. 33. Light Moselle or Rhine wine at meals. Occasionally beer during the day when in Germany, seldom here. Occasionally milk punch of rum: seldom take any stimulant previous to work. Have lived as above nearly all my life. Do not drink whiskey, and take brandy only as medicine: believe in moderate stimulants as recuperator after work; never take them before.

No. 34. My personal experience is that a moderate use of *good* wine or spirits is conducive to health, and that people who cannot be moderate ought not to use stimulants at all.

No. 35. I doubt whether the use of spirituous or vinous liquors is conducive to health, and equally doubt that the moderate use of either is harmful.

No. 36. I think a man after fifty years can use a little liquor to his benefit if he has character enough not to abuse the use. I believe if used it had better be taken with the regular meals. As to the daily quantity, that would vary in the same manner as that of food. Every man should judge for himself. My observation is never begin to drink too early in life and become slaves to a foolish habit. Young men do not need liquor, and our social functions in this direction are bad.

No. 37. I drink as a matter of habit, and not that I consider it especially healthful; neither have I found it especially harmful. From personal experience I would not advocate partaking of any alcoholic drink. As a dear friend of mine, a German professor of medicine, once said to me when we were discussing the same subject, "I have known thousands to die from the effects of drink, but never knew one to die from the want of it."

No. 38. I have seen or experienced no ill effects from a moderate consumption of liquor, but believe the regular use in many cases to be injurious, and especially in stand-up drinks. I think the main evil comes from the habit of treating, and in not considering it proper or manly to accept a drink without returning it as soon as the first drink has been finished.

No. 39. From experience I find that a small quantity of light wine with one meal a day materially increases my capacity for mental work. When the use of one gill of claret daily has been discontinued for a week or so, I find myself less inclined to mental work and apparently suffer greater physical fatigue in accomplishing such work. My experiences under other conditions are set forth in the March, 1887, "Forum," under the title of "The Use of Alcohol in High Latitudes." Except where the experiences of other parties are clearly set forth in said article, the experience and observation are my own.

RELATIONS OF DRINK HABITS TO INSANITY.

BY

J. S. BILLINGS, M. D.

RELATIONS OF DRINK HABITS TO INSANITY.

At the suggestion of the Physiological Sub-Committee the American Medico-Psychological Association undertook to obtain some data with regard to the relations between drink habits and insanity, and for this purpose the following form of queries was prepared corresponding to that used by the Bureau of Statistics of Labor of Massachusetts, in its twenty-sixth annual report, published in 1896. 30,000 of these forms were sent out to 117 state hospitals and asylums for the insane, and as a result 5145 cases were reported, being the current admissions at a certain number of these hospitals for one year. An effort was also made to secure data from some of the large general hospitals with reference to the drinking habits of the patients as admitted, but it did not meet with much success.

A report has been received from Bellevue Hospital of New York city, furnished by the courtesy of Dr. W. Gilman Thompson, giving the record of 506 cases in the wards of Dr. Thompson's service, and giving the drink habits of each case, and also a note on 550 cases from the Presbyterian Hospital.

The data obtained for the insane have been compiled into tables, which are herewith presented. From these tables it appears that of the 5145 insane persons, 2008 or 39.03 per cent. were total abstainers. In the Massachusetts statistics for 1836 persons, 36.87 per cent. were reported as total abstainers, while of the patients at Bellevue only 14 per cent. were reported as total abstainers, and at the Presbyterian 25.28 per cent.

Of the excessive drinkers among the insane there were 12.22 per cent., the Massachusetts statistics giving 16.94 per cent., Bellevue Hospital 21.54, and the Presbyterian 14.90 per cent.

Of those cases reported from insane hospitals the insanity was considered to be due to the influence of liquor in 1239 cases, or 24.08 per cent. The corresponding figure in the Massachusetts statistics is 20.86 per cent.

COMMITTEE OF FIFTY.

RELATIONS OF LIQUOR PROBLEM TO INSANITY.

1 (Name of Institution filling this Schedule.)	(Average insane population.)

City________________ State________________

2 (Date of Admission.) ____________ 189___	3 (City.)	4 (State.)
5 (Christian Name.)	6 (Surname.)	
7 (Sex.) M F	8 (Age.)	9 (Occupation.)

PLACE OF BIRTH OF

10 (Patient.)	11 (Father.)	12 (Mother.)

13 (Citizen or Alien.) C B N A	14 (Language Spoken.) E and

15 Do you regard the patient's Insanity as due to the use or abuse of Intoxicating Liquors?	Y	N	N A
16 Do you believe that the Intemperate Habits of one or both parents led to the Insanity of the person considered?	Y	N	N A
17 Do you believe that the Intemperate Habits of the Grand-parents of the person considered led to his (or her) Insanity?	Y	N	N A
18 Do you believe that the Intemperate Habits of Others (not parents or grandparents) led to the Insanity of the person considered?	Y	N	N A

LIQUOR HABITS.			KIND OF LIQUOR.		
19 Person.	20 Father.	21 Mother.	22 Person.	23 Father.	24 Mother.
E D S D H D P D O D	E D S D H D P D O D	E D S D H D P D O D	W L B M L D L	W L B M L D L	W L B M L D L
T A	T A	T A			

N. B. Draw a line across the letters designating the answers *not* applicable to the case.
The letters C B, N, and A, under inquiry 13, denote respectively "Citizen Born," "Naturalized," "Alien." Letters under inquiries 15–18 Y, N, and N A stand for "Yes," "No," "Not Ascertained;" E D, S D, H D, P D, O D, T A, under 19–21, for "Excessive Drinker," "Social Drinker," "Habitual Drinker," "Periodic Drinker," "Occasional Drinker," "Total Abstainer;" those under 22–24 denote "Wine," "Lager Beer," "Malt Liquors" (other than lager beer), "Distilled Liquors."

Upon these and other figures presented in these tables it may be noted that the difficulty in measuring the influence of the use of liquor on poverty and crime by means of statistics pointed out by Prof. Farnam in his paper on "Some Economic Aspects of the Liquor Problem," in the "Atlantic Monthly," May, 1899, exists also in the statistical study of the influence of liquor upon disease, physical or mental. As a rule the use of liquor, when it is a cause, is merely one of a number of co-operating cases, while, not infrequently, it is a result rather than a cause of the disease.

The data obtained by the American Medico-Psychological Association as to causes of insanity due to liquor, are largely based on the individual opinion of the observers, and these opinions are given without the data upon which such opinions were based. We do not know what symptoms were observed or record of history obtained, which led a physician to conclude that the insanity was due to the use of liquor, or otherwise, but comparison with the Massachusetts statistics gives percentages so nearly the same that it indicates, upon the whole, that the opinions of the physicians in the two entirely distinct groups were based upon the consideration of the same sort of circumstances.

The information furnished at the time when an insane person is admitted to a hospital, with regard to the cause of disease, is apt to be unreliable. Those habits of the patient which have been the most unusual, attract the most attention, and are given the greatest weight, and in the case of persons whose use of alcoholic drinks has been to excess, such use will be ascribed as the cause, although there may be a number of other causes, both inherited and acquired. In those cases reported as periodical drinkers, it is very doubtful whether the drink habits were causative so much as they were symptomatic. It is evident from the study of the tables that, as a rule, periodical drinking has not been considered as a symptom of disease of the nervous system, though it is well known to be such in many cases.

The large number of excessive drinkers among the Bellevue patients is due to the fact that the proportion of hard drinkers in persons admitted to this hospital is comparatively very high, a large number suffering from alcoholism when they are admitted.

Among those reported from the insane hospitals, the drinking habits of 1060, or 20.60 per cent., could not be ascertained; the Massachusetts statistics giving 26.58 per cent., Bellevue Hospital statistics, 4.54 per cent., and the Presbyterian Hospital 9.27 per cent. It is fair to assume that if the drink habit had been sufficiently marked to enter as a causative factor this would have been ascertained, and therefore the patients may be safely included in the class of moderate drinkers or total abstainers; at all events they can be excluded from the hard or excessive drinkers.

We have no data with regard to the proportion of total abstainers in the class of population from which patients in hospitals for the insane are derived, and therefore do not certainly know whether the proportion of total abstainers is greater or less than among the normal, but the proportion given by these figures, 39.02 per cent., would seem to be at least as high as, if not higher than, the proportion among average adults. In the data for persons in professional and business life collected by the Committee only 18.07 per cent. were found to be total abstainers.

It is certainly improbable that nearly one quarter of the cases of insanity in this country are due to the use of alcoholic drinks, as might be inferred from these figures, and while in a given case of an excessive drinker who becomes insane, the connection between cause and effect may be plausibly made out, it is necessary to take into careful consideration other inherited or acquired abnormities or weaknesses of the nervous system. In any case where there is a tendency to psychic or nervous instability and abnormal action, either inherited or acquired, the excessive use of alcohol may act as the exciting cause, like a torch to inflammable material, but the same result may be produced with any excess creating a strain on the nervous system, and the alcohol would produce no effect upon a nervous system in normally good condition.

Inherited tendency to insanity, due to the use of liquor by parents, is reported in 122 cases. In 26 of these cases the father alone was intemperate, and the mother alone in six cases; while six cases were ascribed to the intemperance of the grandparents.

It would require something more than the usual amount of

attention given to the antecedent history of patients admitted to insane hospitals to determine the sources of inherited intemperance, even if the antecedents give a plain history of intemperate life. These statistics must be received with caution as showing possibilities rather than as definite evidence. To prove that the insanity of one generation is due to alcoholic excess of a previous generation, and is not merely a coincidence, requires that other causes of degeneration shall be carefully studied, and duly allowed for.

2844 or 55.27 per cent. of those reported from insane hospitals were citizens born, the Massachusetts statistics giving 54.58 per cent. of citizens born.

Of those whose insanity was considered to be due to the use of liquor, 44.26 per cent. were citizens born; in males alone this percentage was 59.10, in females 41.74.

It is to be hoped that this preliminary study may be supplemented later by an exhaustive study of selected or representative cases, seeking not alone the relations of the drink habit and insanity, but concomitant causes, as well as the relation of insanity to the drink habit conversely. Thus, in periodical drinkers, it should be ascertained how far the outbreak is a manifestation of a disordered brain. Frequently, it is doubtless rather an effect than a cause. The clinical study of alcohol habitués, and their mental degradation, must be accompanied by pathological investigation before the real truth can be ascertained.

Table I.

Table showing 5144 cases of insanity, the number of each in certain groups of ages, with distinction of sex and of causation.

Insanity due to Liquor.

	Under 20	20–30	30–40	40–50	50–60	60–70	70–80	80	Not ascer.	Total.
M . .	5	123	247	207	111	45	10	1	19	768
F . . .	–	14	35	20	21	10	3	–	–	103
Total.	6	137	282	227	132	55	13	1	19	871

Insanity not due to Liquor.

	Under 20	20–30	30–40	40–50	50–60	60–70	70–80	80	Not ascer.	Total.
M . .	108	483	547	337	233	164	104	35	37	2048
F . . .	74	320	360	277	215	142	88	25	15	1516
Total.	182	803	907	614	448	306	192	60	52	3564

Insanity due to habits of Parents.

M . .	6	26	10	9	4	1	1	–	–	57
F . . .	5	23	20	9	2	3	1	–	2	65
Total.	11	49	30	18	6	4	2	–	2	122

Insanity due to habits of Grandparents.

M . .	–	1	1	1	–	–	–	–	–	3
F . . .	–	–	2	–	–	–	–	–	–	3
Total.	–	1	3	1	–	–	–	–	–	6

Insanity due to habits of Others.

M . .	–	–	1	2	–	–	–	–	–	3
F . . .	–	1	8	2	4	4	–	–	–	19
Total.	–	1	9	4	4	4	–	–	–	22

Insanity cause not ascertained.

M . .	11	76	101	70	34	26	15	8	14	355
F . . .	5	48	49	45	20	19	7	3	8	204
Total.	16	124	150	115	54	45	22	11	22	559
							Grand total.			5144
Tot. M	130	709	907	626	382	236	130	44	70	3234
" F	84	406	474	353	262	178	99	28	26	1910
							Grand total.			5144

Table II.

Table showing 871 cases of insanity due to liquor used by patients, with distinction of sex and nationality.

		DL	W	W LB	W ML	W DL	W LB ML	W LB DL	LB	LB ML	LB DL	LB ML DL	ML	ML DL	W LB ML DL				
Citizen born,	M.	116	14	13	1	5	2	8	12	7	71	45	2	21	117	1	–	19	454
" "	F.	4	2	7	–	–	–	–	1	2	4	1	–	–	17	–	–	5	43
Total . . .		120	16	20	1	5	2	8	13	9	75	46	2	21	134	–	–	24	497
Irish . . .	M.	54	1	2	–	–	–	–	–	2	20	7	1	4	13	1	–	5	110
"	F.	4	4	6	–	–	–	–	–	1	3	5	1	1	12	1	–	4	42
Total . . .		58	5	8	–	–	–	–	–	3	23	12	2	5	25	2	–	9	152
German . .	M.	18	1	2	–	–	2	–	4	–	6	1	–	2	11	–	–	1	48
"	F.	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	2
Total . . .		18	1	2	–	–	2	–	6	–	6	1	–	2	11	–	–	1	50
England, Scotland, Canada,	M.	25	3	1	1	–	–	–	1	1	7	5	1	5	15	–	–	3	68
	F.	2	–	1	–	1	–	–	–	1	1	–	–	–	2	–	–	1	10
Total . . .		27	3	2	1	1	–	–	1	2	8	5	1	5	17	–	–	4	78

All other countries.	M	22	2	1	–	2	–	1	2	–	9	9	–	–	24	–	–	1	73
	F.	–	–	–	–	–	–	–	–	–	–	–	2	–	1	–	1	–	4
Total . . .		22	2	1	–	2	–	1	2	–	9	9	2	–	25	–	1	1	77
Nationality unknown.	M.	6	–	–	–	–	–	–	1	–	2	–	–	–	4	–	–	2	15
	F.	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	2	2
Total		6	–	–	–	–	–	–	1	–	2	–			4	–	–	4	17
																		Grand total	871

Table III.

Table showing 871 cases of insanity due to liquor habits of patients, with distinction of sex and nationality.

Male.	ED	SD	HD	PD	OD	NA	TA	OO	Total.
Citizen born . .	62	21	114	33	16	8	–	–	454
Irish	67	1	33	3	3	3	–	–	110
German . .	35	1	9	2	1	–	–	–	48
Eng., Scot., Can.	39	3	21	2	3	–	–	–	68
All others . . .	46	3	15	4	2	3	–	–	73
Natl'y unknown	6	1	1	3	1	3	–	–	15
Total male .	255	30	193	47	26	17	–	–	768
Female.									
Citizen born . .	17	2	11	5	3	5	–	–	43
Irish	22	4	7	4	1	4	–	–	42
German . . .	1	–	–	–	1	–	–	–	2
Eng. Scot., Can.	4	–	3	1	–	2	–	–	10
All others . . .	2	–	1	–	–	–	–	–	4
Natl'y unknown	–	–	–	–	–	2	–	–	2
Total female .	46	6	22	10	6	13	–	–	103
Grand total .	301	36	215	57	32	30	–	–	871

Table IV.

Table showing 871 cases of insanity due to liquor habits of patients, with distinction of sex and nationality.

Male.	Citizen born.	Irish.	German.	English, Scotch, Canadian.	All other countries.	Natl'y unknown.	Total.
Age under 20 years	2	–	1	1	1	–	5
" 20 to 30 "	82	17	6	7	11	–	123
" 30 to 40 "	163	23	7	25	26	3	247
" 40 to 50 "	118	28	19	20	21	1	207
" 50 to 60 "	60	26	10	6	8	1	111
" 60 to 70 "	17	10	5	8	5	–	45
" 70 to 80 "	5	3	–	–	1	1	10
" 80 to – "	–	1	–	–	–	–	1
Age not ascertained	7	2	–	1	–	9	19
Total male . .	454	110	48	68	73	15	768

Female.	Citizen born.	Irish.	German.	Eng., Scot., Canadian.	All other countries.	Natl'y unknown.	Total.
Age under 20 years	–	–	–	–	–	–	–
" 20 to 30 "	7	4	–	3	–	–	14
" 30 to 40 "	21	8	1	3	2	–	35
" 40 to 50 "	8	6	–	4	1	1	20
" 50 to 60 "	6	12	1	–	1	1	21
" 60 to 70 "	–	10	–	–	–	–	10
" 70 to 80 "	1	2	–	–	–	–	3
" 80 to – "	–	–	–	–	–	–	–
Age not ascertained	–	–	–	–	–	–	–
Total female .	43	42	2	10	4	2	103
Grand total . .	497	152	50	78	77	17	871

Table V.

Table showing 150 cases of insanity due to habits of parents and others. Liquor habits of patients, with distinction of sex and nationality.

Male.	ED	SD	HD	PD	OD	NA	TA	OO	Total.
Citizen born . .	2	5	–	1	12	5	18	–	43
Irish	–	–	–	–	1	–	–	–	1
German	–	2	–	–	1	1	–	–	4
Eng., Scot., Can.	1	1	–	–	–	–	–	–	2
All others . . .	1	3	–	–	5	4	–	–	13
Natl'y unknown .	–	–	–	–	–	–	–	–	B
Total male . .	4	11	–	1	19	10	18	–	63
Female.									
Citizen born . .	–	1	2	1	5	13	41	–	63
Irish	–	–	–	–	1	1	1	–	3
German	–	–	–	–	1	4	2	–	7
Eng., Scot., Can.	–	–	–	–	2	3	1	–	6
All others . . .	–	–	–	–	–	1	1	–	2
Natl'y unknown .	–	–	–	–	–	6	–	–	6
Total female .	–	1	2	1	9	28	46	–	87
Grand total . .	4	12	2	2	28	38	64	–	150

Table VI.

Table showing 63 cases of (male) insanity due to drinking habits of parents, with distinction of nationality.

Male.	ED	SD	HD	PD	OD	NA	TA	Total.
Citizen born . . .	19	2	6	2	3	5	–	37
Irish	1	–	–	–	–	–	–	1
German	1	–	3	–	–	–	–	4
Eng., Scot., Can. . .	2	–	–	–	–	–	–	2
All other countries .	8	1	3	–	–	1	–	13
Natl'y unknown . .	–	–	–	–	–	–	–	–
Total	31	3	12	2	3	6	–	57

Male.	ED	SD	HD	PD	OD	NA	TA	Total.
Insanity due to grandparents . .	–	–	–	–	1	–	2	3
Insanity due to other persons . .	–	–	–	–	–	–	3	3
Grand total . . .	31	3	12	2	4	6	5	63

Table VII.

Table showing 87 cases of female insanity due to drinking habits of parents, with distinction of nationality.

Female.	ED	SD	HD	PD	OD	NA	TA	Total.
Citizen born . . .	13	4	23	2	2	6	–	50
Irish	–	–	–	1	1	–	–	2
German	2	–	1	–	–	1	–	4
Eng., Scot., Can. . .	–	–	2	1	–	1	–	4
All other countries .	–	–	1	–	–	1	–	2
Natl'y unknown . .	–	–	–	–	–	3	–	3
Total	15	4	27	4	3	12	–	65
Female.								
Insanity due to grandparents . .	–	–	–	–	–	1	2	3
Insanity due to other persons . .	–	–	–	–	2	10	7	19
Grand total . . .	15	4	27	4	5	23	9	87

Table VIII.

Table showing 63 cases of insanity due to habits of parents, with distinction of sex, age, and nationality.

Male.	Citizen born.	Irish.	German.	English, Scotch, Canadian.	All other countries.	Total.
Age under 20 years . . .	5	–	–	–	1	6
" 20 to 30 " . . .	21	1	1	1	2	26
" 30 to 40 " . . .	3	–	1	1	5	10
" 40 to 50 " . . .	7	–	–	–	2	9
" 50 to 60 " . . .	1	–	1	–	2	4
" 60 to 70 " . . .	–	–	–	–	1	1
" 70 to 80 " . . .	–	–	1	–	–	1
" 80 to – " . . .	–	–	–	–	–	–
Not ascertained	–	–	–	–	–	–
Total	37	1	4	2	13	57

Male. Insanity due to grandparents.	Citizen born.	Irish.	German.	English, Scotch, Canadian.	All other countries.	Total.
Age 20 to 30 years	1	–	–	–	–	–
" 30 to 40 "	1	–	–	–	–	–
" 40 to 50 "	1	–	–	–	–	–
Total	3	–	–	–	–	3
Male. Insanity due to other persons.						
Age 30 to 40 years	1	–	–	–	–	–
" 40 to 50 "	2	–	–	–	–	–
Total	3	–	–	–	–	3
Grand total						63

Table IX.

Table showing 87 cases of insanity due to habits of parents, with distinction of sex, age, and nationality.

Female.	Citizen born.	Irish.	German.	English, Scotch, Canadian.	All other countries.	Natl'y unknown.	Total.
Age under 20 years	5	–	–	–	–	–	5
" 20 to 30 "	17	1	1	2	–	2	23
" 30 to 40 "	17	–	1	–	2		20
" 40 to 50 "	6	1	1	1	–	–	9
" 50 to 60 "	2	–	–	–	–	–	2
" 60 to 70 "	2	–	1	–	–	–	3
" 70 to 80 "	–	–	–	1	–	–	1
" 80 to – "	–	–	–	–	–		–
Not ascertained	1	–	–	–	–	1	2
Total	50	2	4	4	2	3	65
Female. Insanity due to habits of grandparents.							
Age 30 to 40 years	1	–	–	1	–	–	2
Not ascertained	–	–	–	–	–	1	1
Total	1	–	–	1	–	1	3
Female. Insanity due to habits of others.							
Age 20 to 30 years	–	–	–	–	–	1	1
" 30 to 40 "	5	1	–	1	–	1	8
" 40 to 50 "	1	–	1	–	–	–	2
" 50 to 60 "	4	–	–	–	–	–	4
" 60 to 70 "	2	–	2	–	–	–	4
Total	12	1	3	1	–	2	19

TABLE X.

Table showing insanity due to the drinking habits of each parent.

Male. Father.	Mother.	Total.	Female. Father.	Mother.	Total.
ED	TA	26	ED	TA	8
SD	TA	2	SD	TA	2
HD	TA	4	HD	TA	15
OD	TA	2	PD	TA	2
SD	NA	1	OD	TA	3
HD	NA	5	NA	TA	1
PD	NA	1	ED	NA	7
NA	NA	5	SD	NA	1
TA	ED	1	HD	NA	6
ED	HD	1	NA	NA	10
ED	OD	4	NA	HD	1
HD	PD	1	ED	HD	1
HD	OD	2	SD	OD	1
PD	PE	1	HD	ED	2
OD	ED	1	HD	OD	3
			PD	HD	1
Total		57	Total		65
Due to grandparents . .		3	Due to grandparents		3
" " other persons . . .		3	" " other persons		19
Total		63	Total		87

Grand total, both sexes 150

TABLE XI.

Table showing 150 cases of insanity due to drinking habits of each parent, with distinction of sex.

Male. Father.	Mother.	Total.	Female. Father.	Mother.	Total.
ED	TA	26	ED	TA	8
ED	HD	1	ED	NA	7
ED	OD	4	ED	HD	1
SD	TA	2	SD	TA	2
SD	NA	1	SD	NA	1
HD	TA	4	SD	OD	1
HD	NA	5	HD	TA	15
HD	PD	1	HD	NA	6
HD	OD	2	HD	ED	2
PD	NA	1	HD	OD	3
PD	PD	1	PD	TA	2
OD	TA	2	PD	NA	1

Male. Father.	Mother.	Total.	Female. Father.	Mother.	Total.
OD	ED	1	PD	HD	1
TA	ED	1	OD	TA	3
NA	NA	5	NA	TA	1
			NA	NA	10
			NA	HD	1
Total		57	Total		65
Due to grandparents		3	Due to grandparents		3
" " other persons		3	" " other persons		19
Total, male		63	Total, female		87
Grand total, both sexes					150

Table XII.

Table showing 3564 cases of insanity *not* due to liquor habit, with distinction of sex, age, and nationality.

Male.	Citizen born.	Irish.	German.	English, Scotch, Canadian.	All other countries.	Natl'y unknown.	Total.
Age under 20 years	77	2	4	3	20	2	108
" 20 to 30 "	335	16	25	19	87	1	483
" 30 to 40 "	305	27	58	44	106	7	547
" 40 to 50 "	188	23	49	29	46	2	337
" 50 to 60 "	123	30	23	26	30	1	233
" 60 to 70 "	87	24	20	20	12	1	164
" 70 to 80 "	56	20	10	7	9	2	104
" 80 to – "	23	6	4	1	1	–	35
Not ascertained	20	2	7	–	2	6	37
Total	1214	150	200	149	313	22	2048
Female.							
Age under 20 years	51	4	2	7	9	1	74
" 20 to 30 "	214	27	20	23	32	4	320
" 30 to 40 "	238	26	16	36	41	3	360
" 40 to 50 "	166	16	31	42	21	1	277
" 50 to 60 "	25	135	15	26	13	1	215
" 60 to 70 "	77	23	18	16	7	1	142
" 70 to 80 "	51	22	7	6	2	–	88
" 80 to – "	18	6	–	–	–	1	25
Not ascertained	4	1	2	1	6	1	15
Total	844	260	111	157	131	13	1516
Grand total	2058	410	311	306	444	35	3564

Table XIII.

Table showing 3564 cases of insanity *not* due to liquor habit, with distinction of sex and nationality.

Male.	ED	SD	HD	PD	OD	NA	TA	Total
Citizen born . .	21	125	20	15	296	123	614	1214
Irish	4	9	3	7	57	3	67	150
German	3	26	3	2	78	10	78	200
Eng., Scot., Can. .	3	15		3	39	16	73	149
All others . . .	5	43	2	2	106	11	144	313
Natl'y unknown .	2	1	–	2	4	4	9	22
Total male . .	38	219	28	31	580	167	985	2048
Female.								
Citizen born . .	2	24	3	3	83	219	610	944
Irish	1	5	3	1	39	55	56	160
German	–	17	2	–	24	18	50	111
Eng., Scot., Can. .	1	5	–	–	16	65	70	157
All others . . .	–	10		-	13	29	79	131
Natl'y unknown .	–	1	-	--	2	8	2	13
Total female .	4	62	8	4	177	394	867	1516
Grand total .	42	281	36	35	757	561	1852	3564

Table XIV.

Table showing 559 cases, cause of insanity not ascertained, with distinction of sex and nationality.

Male.	Citizen born.	Irish.	German.	English, Scotch, Canadian	All other countries.	Natl'y unknown.	Total.
Under 20 years . .	6		1	–	3	1	11
20 to 30 " . .	53	1	1	3	10	8	76.
30 to 40 " . .	61	2	11	6	17	4	101
40 to 50 " . .	35	3	6	6	14	6	70
50 to 60 " . .	22	3	1	1	2	2	34
60 to 70 " . .	11	4	6	–	3	2	26
70 to 80 " . .	3	4	4	2	1	1	15
80 to – " . .	2	2	1	–		3	8
Not ascertained . .	3	-	1	2	2	6	14
Total male . . .	196	19	35	20	52	33	355
Female.							
Under 20 years . .	5	–	-	–	—	–	5
20 to 30 " . .	21	2	10	2	10	3	48
30 to 40 " . .	21	7	3	1	13	4	49
40 to 50 " . .	17	4	9	5	6	4	45
50 to 60 " . .	7	5	3	1	3	1	20
60 to 70 " . .	10	1	3	1	4		19

Male.	Citizen born.	Irish.	German.	English, Scotch, Canadian.	All other countries.	Natl'y unknown.	Total.
70 to 80 years . .	3	2	–	–	2	–	7
80 to – " . .	2	1	–	–	–	–	3
Not ascertained . .	1	1	–	–	1	5	8
Total female . .	57	23	28	10	39	17	204
Grand total . .	283	42	63	30	91	50	559

Table XV.

Table showing 559 cases, cause of insanity not ascertained, with distinction of sex, age, and nationality.

Male.	ED	SD	HD	PD	OD	NA	TA	Total.
Citizen born . .	10	45	3	5	30	70	33	196
Irish	–	1	1	–	7	10	–	19
German	1	3	1	–	5	24	1	35
Eng., Scot., Can.	2	–	3	–	1	10	4	20
All others . . .	–	1	1	–	3	43	4	52
Natl'y unknown .	–	–	–	–	–	33	–	33
Total male .	13	50	9	5	46	190	42	355
Female.								
Citizen born . .	1	1	–	–	1	55	29	87
Irish	1	–	2	1	1	13	5	23
German	–	1	1	–	1	18	7	28
Eng., Scot., Can. .	–	–	–	–	–	7	3	10
All others . . .	1	–	1	–	1	33	3	39
Nat'ly unknown .	–	–	–	–	–	14	3	17
Total male . .	3	2	4	1	4	140	50	204
Grand total .	16	52	13	6	50	330	92	559

The following memorandum upon the drink habits of patients at Bellevue Hospital, New York city, under the care of Dr. W. Gilman Thompson for one year, has been furnished by Dr. Thompson: —

Total number treated in the wards of Dr. Thompson's service for one year	506
Males	380
Females	126
Of these there were hard drinkers, males	101
Females	8
Total	109
Per cent.	21.54

Moderate drinkers, males	231
Females	72
Total	303
Per cent.	59.88
Abstainers, males	35
Females	36
Total	71
Per cent.	14.03
Not ascertained, males	13
Females	10
Total	23
Per cent.	4.54
Drinkers of spirits, males	14
Malt liquors, males	78
Wines	5
Spirits and malt liquors together	178
Drinkers of spirits, females	3
Malt liquors	34
Wine	7
Spirits and malt liquors together	27

A considerable proportion admitted into this service are suffering from alcoholism when admitted, and the proportion of hard drinkers is very high: a large proportion of them are foreigners and are mainly Irish and German.

THE INFLUENCE OF ALCOHOL ON GROWTH AND DEVELOPMENT

BY

C. F. HODGE, Ph. D.
PROFESSOR OF PHYSIOLOGY, CLARK UNIVERSITY

THE INFLUENCE OF ALCOHOL ON GROWTH AND DEVELOPMENT

The following experiments were undertaken for the purpose of studying the influence of alcohol upon the more general physiological processes, such as growth, vigor, and resistance to disease, health, activity and development of intelligence, normality and viability of offspring. In all four series of investigations have been made: —

1. Upon the influence of minute percentages of alcohol on the growth of yeast.

2. The influence of moderate doses of alcohol upon the growth of kittens.

3. The influence of alcohol upon the growth, intelligence, activity, and offspring of dogs.

4. Influence of alcohol on the daily activity of rats.

The work was begun in the fall of 1895, and reports of these experiments up to dates of publication have been printed in various journals.[1] It is proposed here to give a brief summary of these publications and of additional results up to the present date.

The point of view from which the work was undertaken was that most of the apparent contradictions in the results of attempts at the solution of the alcohol problem are due to the great complexity of the human organism. Of all animals man is the most adaptable to all sorts of conditions of life. Some men fail with alcohol, others fail as completely without it, and

[1] "Experiments on the Physiology of Alcohol made under the Auspices of the Committee of Fifty," Appleton's *Popular Science Monthly*, March and April, 1897.

"Influence of Alcohol on the Viability of Offspring of Dogs and on their Susceptibility and Resistance to Distemper," *Journal of the Boston Society of Medical Sciences*, December, 1897.

"Variations in Daily Activity produced by Alcohol, and by Changes in Barometric Pressure and Diet, with Description of Recording Methods," Colin C Stewart, *American Journal of Physiology*, vol. i. 1898.

the same is true of success. This has made the definite interpretation of the human experiment impossible. The method of physiological science is to reduce the problem to simplest terms in every way possible. A unicellular organism is millions of times simpler than a human body: still all fundamental functions and processes, such as nutrition, growth, reproduction, excretion, appear similar in both. Hence by studying the influence of alcohol upon these functions in simpler organisms, evidence may be gained by which more clearly to interpret the human experiment. The lower animals, complex as they are, are much simpler in all their physiological adaptations than man, and yet approach him more closely in the details of physiological processes, and thus render closer comparison possible. Their conditions of life, moreover, may be made more nearly comparable than it would ever be possible to find or procure with men. In man, even after death, microscopical investigation of the tissues to demonstrate the influence of alcohol upon them is so complicated by all manner of disease and by post-mortem changes that no wholly trustworthy evidence is obtainable. Animals, on the other hand, may be killed in known conditions of health, and their tissues may be immediately prepared for microscopical examination. In this way important results have been obtained by Berkley,[1] Dehio,[2] Stewart,[3] and others, that have materially aided the interpretation of findings in human tissues.

Four types of physiological influence that alcohol may exert on a vital function are represented to the eye in the left hand diagram of Fig. 1. It may have no effect, as represented by the line marked "normal." It may stimulate activity, dotted line Y, or it may depress, or decrease activity, dotted line X, or, finally, small amounts may exert a proportionally greater influence than larger quantities, heavy line X. This last was found to be the influence of minute percentages of alcohol on

[1] Henry J. Berkley, "Studies of the Lesions produced by the Action of Certain Poisons on the Cortical Nerve Cell," *Alcohol, Brain*, 1895, p. 473.

[2] Heinrich Dehio, "Experimentelle Untersuchungen über die Veränderungen der Ganglienzellen bei der acuten Alkoholvergiftung." *Centralbl. für Nervenheilkunde und Psychiatrie*, 1895, p. 113.

[3] Colin C. Stewart, "Influence of Acute Alcohol Poisoning on Nerve Cells," *Journal of Experimental Medicine*, vol. i. No. 4, 1896.

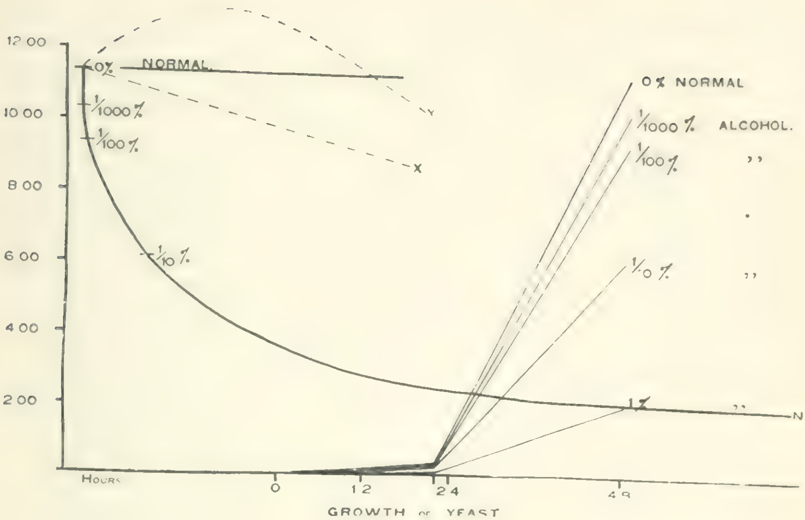


FIG. 1.

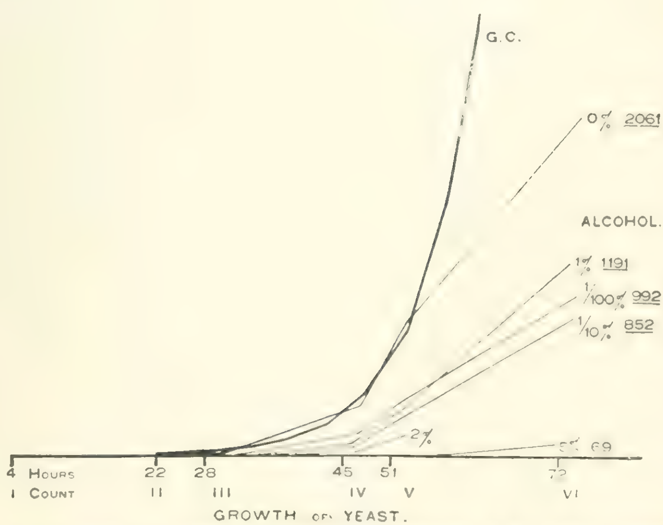


FIG. 2. — G. C., curve of a geometrical progression increasing at the rate of yeast growth in the normal cultures for the first twenty-four hours. The numbers at the right indicate the number of *torula* found in a cubic millimetre of the different cultures.

the growth of yeast. The line X in the diagram is, in fact, plotted from the results of the fifth series of experiments. The figures from which the curve is drawn are as follows: —

Growth of yeast, series 5.

Per cent. of alcohol.	Count Y. 18 hours.
0. %	1102
0.001 %	999
0.01 %	912
0.1 %	602
1. %	216

The diagram at the right in the figure expresses the same result as a race, a competitive effort, in which the cultures containing no alcohol are seen to win, the others falling below proportionately to their alcohol content. Fig. 2 is a similar expression for the third series of experiments. The method of uniformly seeding the cultures had not been perfected: still the same general effect is apparent. And this is the unquestionable result in all the experiments, fifteen in number.

The form of the curves derived from all these experiments is that ordinarily obtained for the physiological fatigue of a tissue, muscle, nerve, or gland. This is what we should expect, since an important factor in causation of fatigue is accumulation of waste products, and alcohol is a waste product in the activity of the yeast plant. Alcohol is probably, also, a partial decomposition product in the metabolism of a number of animal tissues, such as brain, muscle, and liver, but with some or all of these it is further oxidized to carbon dioxide and water.[1] While of considerable physiological interest, the fact that alcohol in such minute traces interferes with the growth processes of so simple an organism as yeast, this result cannot be directly applied to organisms capable of oxidizing alcohol.

Kittens, as comparable as it was possible to find them, were secured, alcohol was given to one pair, keeping a number of others as controls. It was intended to breed from them, if possible, and follow a similar line of experiments as those to be subsequently described for the dogs. The doses of chemically pure alcohol, diluted with water to twenty, and later to thirty

[1] Schäfer, *Text-book of Physiology*, vol. i. 1–882, Edinburgh and London, 1898. Also Hoppe-Syler, *Handbuch der chemischen Analyse*, Berlin, 1893, p. 40.

per cent., began with 1.3 grammes, and were increased to 3.6 per kilogramme of body weight. Since kittens refuse to drink milk with even the odor of alcohol about it, the doses had to be given with a stomach pump, and the same amount of water was given the normals. Ten days of this regimen, however, was followed by so complete a collapse that alcohol was discontinued, until approximately normal health should be restored. This did not prove possible, the male lingering along, with very little gain in weight, for about four months, and the female partially recovered, but was killed by a dog. The disease that developed, first in the alcoholic kittens, seemed to be an acute catarrh of respiratory and alimentary systems with conjunctivitis. Some weeks later all the normal kittens were affected in the same way, and either died or were killed in the last stages of the disease. Practically all the cats in the neighborhood were affected in the same way, and the experiment was abandoned.

Fig. 3 gives at a glance the relative growth of the kittens during the course of the experiment. It will be noted that those having been given the alcohol are much stunted as compared with all the others, but whether this is caused by the alcohol or the disease it is impossible to say.

In beginning the experiment, it was remarkable how quickly and completely all the higher psychic characteristics of both the kittens dropped out. Playfulness, purring, cleanliness and care of coat, interest in mice, fear of dogs, while normally developed before the experiment began, all disappeared so suddenly that it could hardly be explained otherwise than as a direct influence of the alcohol upon the higher centres of the brain. Fig. 4 presents the characteristic appearance of the alcoholic kittens. They simply ate and slept, and could scarcely have been less active

FIG. 4. Alcohol-diseased kittens 1 and 3, June 4, 1895: characteristic attitude. When the photograph was taken, 5 P. M., all the normal kittens were playing actively.

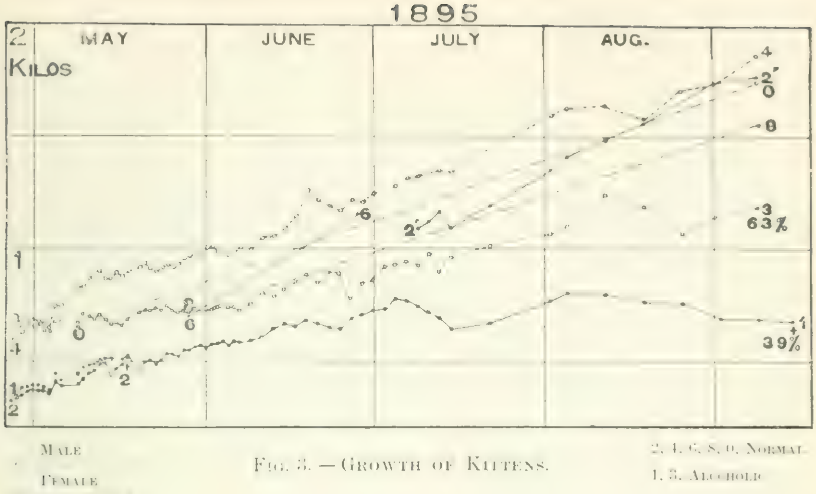


Fig. 5. — Growth of Kittens.

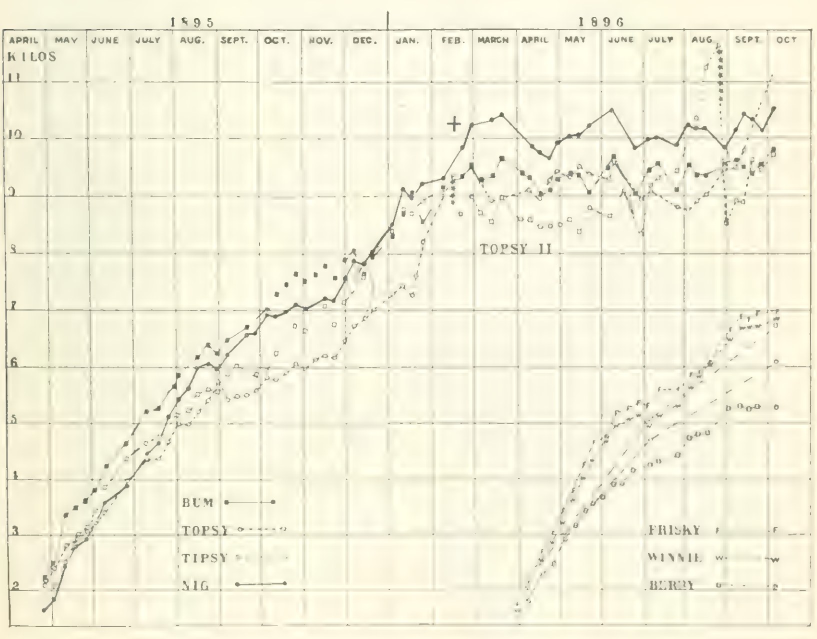


Fig. 6. — Growth of the Dogs.

BUM. TIPSY. NIG. TOPSY.

FIG. 5. — NOVEMBER 27, 1895.

BUM. TIPSY. NIG. TOPSY II.

FIG. 12. — OCTOBER, 1896.

had the greater part of their cerebral hemispheres been removed by the knife. None of the other normal kittens showed anything like so sudden and complete a collapse.

In a series of experiments upon dogs which, it was intended, should be continued during the length of their natural lives, neither pains nor expense was spared to obtain animals as comparable as possible and of good stock. The four cocker spaniels presented in Fig. 5 were finally selected, and for all purposes of the experiment they have been in breed and strain all that could be desired. Although belonging to two not closely related kennels, the four happened to have been born on the same day, February 22, 1895.

April 29 they weighed as follows: —

Tipsy . . .	2102 grammes.	Bum . . .	2179 grammes.
Topsy . . .	2150 grammes.	Nig . . .	1556 grammes.

Topsy and Tipsy are sisters, Nig and Bum, brothers from their respective litters.[1]

After preliminary study, in order to discover minor differences in disposition, health, or character of the dogs, it was decided to give the alcohol to the more vigorous pair, Tipsy and Bum. Accordingly its administration, in the form of tested, chemically pure alcohol, thoroughly mixed with their chief meal, was begun on May 24 following.[2]

The dogs were weighed, at first daily, later once a week, and their growth may be read from Fig. 6, together with that of a subsequent group to be described later. No "stunting" effect of alcohol as administered is to be found in this growth chart. Probably four puppies could not be found to grow more uniformly under ordinary treatment. Measurements also showed that the bony frame in each of the dogs was about the same

[1] The only apology I have to offer for the names is that in long-continued experiments of this kind names must be chosen for daily use, and need to be, with dogs, phonetically distinct, to avoid confusion. I thought it also desirable for long series of notes and descriptions that the name suggest the treatment to which the animal was subjected.

[2] Alcohol, ordered for the purpose from Kahlbaum, was used throughout the experiments, and each lot was especially tested. The plan of the experiments, with the sub-committee's approval, was to give as large doses as possible short of producing noticeable intoxication. This dose was found for the dogs to be four cubic centimetres per kilogramme of body weight. For further details, refer to Appleton's *Popular Science Monthly*, April, 1897.

in relation to the others as its weight. That is, there was no evidence of excessive development of fat that might have kept up the weight while the framework of the body remained undersized. Since both "stunting" and accumulation of fat are often insisted upon as due to direct effects of alcohol, these are important facts in its general physiology.

Before passing to topics of more general physiological interest, we may turn aside for a moment to consider briefly three series of collateral experiments.

The first of these, begun in April, 1896, had for its object the testing of ordinary commercial liquors, an ordinary whiskey, wine, and beer. Three puppies of the same strain and from the same litter were secured, and the respective liquors were administered as indicated again by the names of the dogs.[1] Their growth chart, with Topsy's and Tipsy's superimposed for corresponding months, is given in Fig. 6. Frisky and Winnie are seen to grow normally, while Berry falls considerably below. Their health remained apparently good until June, when they all broke out with eczema, Berry having it worst, Winnie not quite so bad, and Frisky lightest of all. The growth of Frisky and Winnie, at least, indicates the absence of deleterious ingredients in the wine and whiskey, and it is certainly going beyond the evidence to attribute the eczema to anything except the water in the liquors. This was its first appearance in the kennel, and neither Tipsy nor Bum was affected. Kennel manuals uniformly caution against making the food of puppies "sloppy," chiefly on account of danger from eczema, and the percentages of water in the liquors (whiskey, 67%, wine, 82%, beer, 95.7%) made this necessary, especially with the wine and beer, if amounts of alcohol at all comparable with the other experiments were given.

Two more experiments were made to test whether Berry's deficient growth should be considered a beer effect. One of these consisted in selecting three of Topsy's male puppies as

[1] Frisky's dose was 100 cc. of whiskey, of 33% ; Winnie's, 120 cc. of wine, Burgundy, of 18% ; and the largest amount that Berry could be induced to take was 125 cc. of beer, of 4.3%, alcohol content. The fate of each of these dogs may conveniently be stated here as follows : Berry was run over on the street and killed in the fall of 1896, Winnie died of distemper the following summer, and Frisky is still alive.

FRISKY. WINNIE. BERRY.

FIG. 7. — OCTOBER, 1896.

TEETO. MINNEHAHA. BERRY II.

FIG. 8. — NOVEMBER, 1897.

comparable as possible, and giving to two of them as much beer as they would take, keeping the third one on normal diet. Their weights are shown in the following table: —

Weight of puppies, third beer experiment.

At birth, Oct. 20, 1897.	Jan. 1, 1898, beer, 50 cc. twice daily to Jan. 8.	Mar. 20, 1898, beer, 100 cc twice daily from Jan. 8 to date.[1]
Normal, 358 gms.	3660 gms.	6860 gms.
Berry III., 219 gms.	3490 gms.	7050 gms.
Berry IV., 218 gms.	3540 gms.	7550 gms.

[1] Experiment discontinued.

Plainly this experiment gives no support to the first. And nothing abnormal was remarked about the animals, except that they became much more timid than any of the other puppies in the kennel at the time. This is a point of importance to be reserved for discussion in its proper place, but it was noted that if a stranger came into the kennel, all the normal pups would rush forward to make friends, while these two would run away.

The other experiment, begun in the fall of 1896, and continued for over two years, was made with three of Topsy's female puppies. One was given normal diet, a second was given beer, and the third had an amount of water equal to the beer. The puppies were named for convenience, respectively, Teeto, Berry II., and Minnehaha. A few of their weight relations may be read below: —

Weight of puppies, second beer experiment.

At birth, Oct. 27, 1896.	Jan. 1, 1896, beer and water, 50 cc. each. Jan. 17, twice daily, 75 cc.	Jan. 24, 1897, 100 cc. each twice daily to May, 1897.	Oct. 10, 1897, 200 cc. once daily thereafter to last date.	Mar. 12, 1898.
Teeto, 250 gms. . . .	2660	3690	7000	8510
Berry II., 220 gms. . .	3280	4650	9570	11,390
Minnehaha, 260 gms. .	3100	4280	9300	9470

Relations of stature are equally instructive, and may be given for November 14, 1897, when the dogs had practically attained their growth: —

	Length in cm.	Height in cm.
Berry II.	68	33
Minnehaha	61	24
Teeto	51.5	24
Topsy	61	31
Nig	61	29

These size relations are further shown in Fig. 8, which should be compared with Fig. 7, before deciding upon any "stunting" effect of beer.

It should be added that Teeto was the only well-formed dog in the group. Both Minnehaha and Berry II. presented the lanky, scrawny appearance characteristic of the dogs in the first experiment. Both Teeto and Minnehaha conceived normally, while Berry proved completely sterile.

The beer was given, as in the case of alcohol and the other liquors, uniformly with the meals, twice daily up to about six months of age and once daily thereafter. Although frequently offered, none of the animals ever took any of the liquors when unmixed with food, and no trace of an "alcohol habit" could be detected. The reverse, in fact, was uniformly noted, and, when given the choice, all the dogs experimented with showed a decided preference for food that did not contain alcohol or any form of alcoholic liquor.

Having gained a general introduction to all the dogs in the kennel, we may now take up the different phases of their general physiology. And first we may properly discuss the health, vigor, and freedom from disease of all the animals for the entire research.

Kennel hygiene has been maintained practically perfect throughout. The dogs have had a large sunny yard of nearly a quarter of an acre, and whenever possible have been given complete freedom besides. They have had a new, dry, clean kennel, which has been thoroughly disinfected twice a year, the best of food, Spratt's biscuit, milk, eggs, wholesome meat, and plenty of gnawing bones; and clean fresh water, renewed twice and three times a day in warm weather. Regular and careful attention was given to both external and internal parasites, and no complications have arisen from these sources. All these conditions have conspired to render the experiments physiologically ideal. As a consequence, with one exception,[1] the health

[1] In the spring of 1896 Bum developed unilateral goitre. This yielded

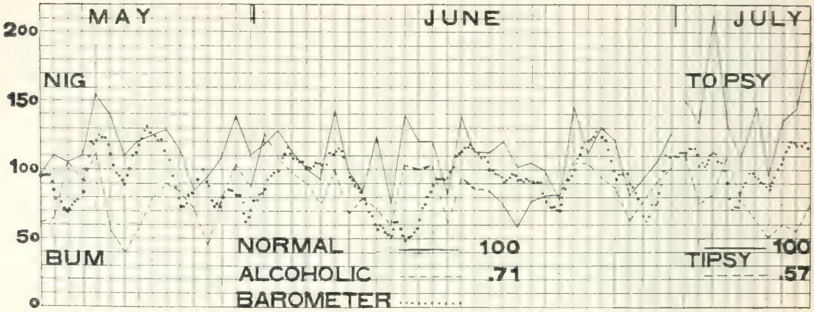
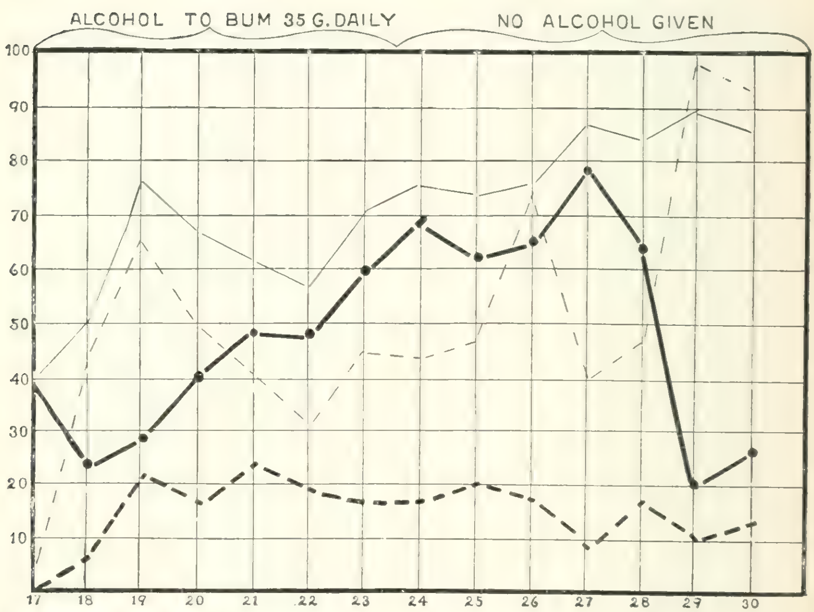


FIG. 9. — DAILY ACTIVITY.



NIG RETRIEVES
" ATTEMPTS
BUM RETRIEVES
" ATTEMPTS

FIG. 10. — CURVE OF EFFICIENCY (COMPETITIVE). In a difficult competitive test calling for endurance, sustained attention, etc., the alcoholic falls much lower relatively than in ordinary daily activity, Bum attaining to only thirty-two per cent. of Nig's efficiency.

of the dogs remained perfect for nearly two years and a half.

The spring and early summer of 1897 were extremely wet. Distemper became epidemic throughout the city, and assumed a malignant type. Sick dogs were not uncommon on the streets. Many dogs died, Mr. Browning's kennel, from which all the females in our experiments were obtained, losing fifteen outright. Of course, this sickness and loss occurred in kennels, and among individuals maintained under what are usually considered normal conditions. The history of the epidemic in our own kennel thus derives practically all its significance from the possession of adequate controls in the normal dogs.

The dogs in the kennel at the time were: —

Alcoholic.	Normal.
Bum,	Nig,
Tipsy,	Topsy II.,
Frisky,	Teeto,
Winnie,	Minnehaha.
Berry II.	

The disease appeared first in Winnie, July 6, and she died the evening of the 8th. She had four days previously given birth to four whelps, all of which had died before the close of their second day. Tipsy was second to come down, July 9th. The affected dogs were promptly isolated from the rest, but Frisky was added to their number July 12, and Bum the day following.

I have since been assured that they all passed through a mild form of the disease, but none of the other dogs developed the more characteristic symptoms of distemper. They were all rather sluggish for a few days, and discharged somewhat from the eyes and nose: but they were not observed to cough and retch, and they did not lose flesh or appetite.

With the four alcoholic dogs it assumed its severest form. The symptoms usually described as diagnostic developed rapidly, excessive weakness and prostration, great loss of flesh, and complete absence of appetite. Frisky, however, rallied promptly, and was out of danger within a week. With Tipsy and Bum

promptly to the proper treatment, which consisted in painting with tincture of iodine, and giving small doses of dessicated thyroid, and has not appeared since.

the disease assumed a much more serious form. Both were affected exactly alike, were completely prostrated, and refused nourishment of every kind, so that for a week I was compelled to drench them with hot milk and eggs at frequent intervals. In both cases the corneas ulcerated badly, the ulcers being held in check with great difficulty by frequent applications of eye washes. All four corneas became completely clouded, and both dogs were temporarily blind. For over two weeks I hardly expected either of the dogs to live from day to day. Under ordinary care, I have little doubt that both would have died. I resorted, however, to every possible device for feeding and proper medication. Alcohol was omitted from their diet, and though frequently offered to them, they invariably refused food containing it.

After their severe sickness both dogs gained flesh rapidly, and none of the nervous sequelæ, so often worse than distemper itself, made their appearance. The eyes healed and cleared up, with the exception of one of Tipsy's, which remained permanently clouded and blind.

In a word, the line was quite sharply drawn in the kennel between the normal and alcoholic dogs. All the alcoholic dogs, with exception of Berry II., and she had had the least alcohol of all, had the disease with considerable or very great severity. All the normal dogs had it in the mildest form possible. This would seem to indicate, for distemper, at least, if not increased susceptibility to infection, a much diminished power of resistance on the part of the alcoholic dogs. The bearing of this result on various human diseases is too patent to require reference. Distemper would probably prove an interesting disease with which to study, in greater detail and with more exactness than was possible under the circumstances, comparative susceptibility to infection and resistance to disease in alcoholic and normal animals.

The normal daily activity of the animals, development of intelligence, and ability to withstand fatigue in the performance of difficult muscular feats, are topics naturally associated with the health and vigor of the nervous and muscular systems. To test daily activity a form of pedometer was devised [1] which could

[1] For these pedometers Waterbury watches were taken, the hair springs removed, the balance wheel weighted on one side, and guard pins inserted

Bum. Tipsy. Nig. Topsy.

Fig. 13. — November, 1895.

Bum. Tipsy. Nig. Topsy.

Fig. 20. — December 1, 1900.

be strapped in the dogs' collars and read at corresponding times. Soon after beginning to administer alcohol it was often noted that the normal dogs were playing actively while the others were quiet. A quantitative expression of this difference is given for the months indicated in 1896, in Fig. 9, and since a number of investigations have shown that muscular and mental ability in men and animals tend to vary with the barometer, its curve for the time is superimposed.[1] Bum is seen to develop only 71% of Nig's, and Tipsy only 57% of Topsy's spontaneous activity. A like tendency to quiet was noted in the other dogs to which alcoholic liquors were given with exception of those having beer. They, to all appearance, remained as lively as ever.[2]

These results give, of course, no expression of the quality of activity, and to devise a test that would give the comparative ability of the dogs as to strength, endurance, and resistance to fatigue, they were all taught to retrieve a ball when thrown. When it was desired to make a test, the dogs were all taken to the university gymnasium, and a rubber ball was thrown across the room, a distance of one hundred feet, as fast as it could be retrieved. A record was kept of all the dogs that started for the ball, and of the one that brought it back. One hundred balls constituted a test, and to throw them consumed about fifty minutes.

The first series consisted of 1400 balls, thrown on fourteen successive days, January, 1896, and the two normal dogs retrieved 922, the alcoholics, 478. This gives the alcoholics an efficiency of 51.9% as compared with the normals. Bum's ability

that would permit the release of one tooth of the escapement every time the watch was shaken. A very delicate pedometer resulted that recorded every movement of the animal. Two of these were carefully adjusted so as to run alike, in whatever position placed or however shaken, and were then placed in stout leather pockets in the collars of the two dogs whose activity it was desired to test. They were then read daily at exactly the same time, six o'clock P. M. To insure any change in the watches affecting the results, they were interchanged from dog to dog every three days, so that each dog wore the same watch the same number of days. No such variation, however, in the watches was observed to occur.

[1] For the barometric record we are indebted to Mr. Martin Green, of Worcester.

[2] Dr. Stewart obtained a similar result with rats, except that there was an initial increase of activity on beginning administration of alcohol.

as compared with Nig's is only 32% (see Fig. 10). Tipsy and Bum also gave evidence of very much greater fatigue. A similar series of 1000 balls, November, 1896, in which Bum and Nig only participated, shows about the same result, and expresses (Fig. 11) these relations as to fatigue more exactly. Nig's curve of achievement is also seen to run much closer to his curve of attempt than in Bum's case, in both charts, and this affords good evidence of his greater alertness, strength, and energy.

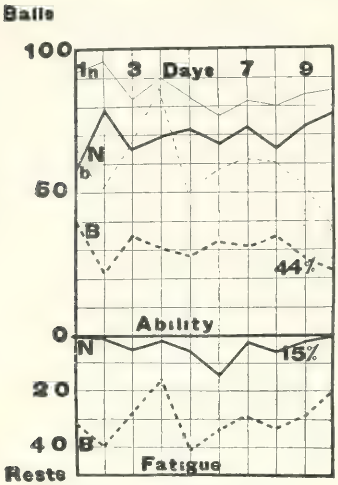


Fig. 11. Chart of Ball Tests.

These differences, especially on the psychic side, are well shown by all the photographs that have been taken. Comparison of the faces in Figs. 5, 12, 13, and 20 demonstrate this too clearly to require further comment. It should be noted, however, in Fig. 20, that Bum is completely blind, which give the eyes a somewhat more wide-awake expression, and the direct sunlight, in which the picture is taken is rather strong for the eyes of the other dogs.

Administration of alcohol was discontinued November 1, 1898, in order to ascertain whether the effects of alcohol already noted were transient or permanent. This point in the research has special reference to its influence on progeny, as will be described under that head, but it is also of interest in connection with the normal activity of the animals. This was at the beginning of Tipsy's last gestation period, and no marked change in her general behavior could be noted up to the time of her death the following December.

Bum's activity improved slowly, so that by the end of a year it had attained practical equality with Nig's, a test with the watches at this time giving the relation of 95% to Nig's 100%. Ball tests, also, made in the spring and fall of 1899, showed him to be about Nig's equal both in alertness and endurance.

During the winter of 1899–1900, without any apparent cause, atrophy of both retinæ began to be noticeable, and by the spring

Fig. 14. — Bum, November, 1895.

Fig. 15. — Nig, November, 1895.

of 1900 Bum had become totally blind. This, of course, has made further tests of activity and strength either impossible or useless. For the past season he has also been the only dog in the kennel to suffer from eczema. This has involved large tracts of the skin, and has been difficult to heal or control. Both these afflictions have contributed to give to Bum the appearance of an old feeble dog, while Nig is still in the prime of health and vigor.

On the side of general intelligence the alcoholic dogs have been in no wise inferior to their mates. They have been, if anything, more teachable and much more easily controlled in learning the few things necessary to their education.

A striking result of the entire research, and one entirely unexpected on account of the small doses of alcohol given, has been the extreme timidity of the alcoholic dogs. Magnan obtained a similar result with his dog, more extreme, because he gave large amounts of alcohol. While able to hold their own with the other dogs in the kennel, the least thing out of the ordinary caused practically all the alcoholic dogs to exhibit fear, where the others evinced only curiosity or interest. Whistles and bells, in the distance, never ceased to throw them into a panic in which they howled and yelped while the normal dogs simply barked. This holds true of all the dogs that had alcohol in any amount. During the first year of the experiment Bum had a number of paroxysms of causeless fear with some evidence of hallucinations. He would apparently start at some imaginary object, and go into a fit of howling.

This point is well illustrated by photographs taken on the same day and under exactly similar conditions. (Figs. 14–17.)

It would seem from all the evidence that we are dealing with one of the profound physiological causes of fear, having wide applications to its phenomena in man. Fear is commonly recognized as a characteristic feature in alcoholic insanity, and delirium tremens is the most terrible fear psychosis known. We should naturally look for its effects in the cells of the brain itself, and the researches of Dehio, Berkley, and Stewart all point to alterations in various staining reactions in these cells.

With the discontinuance of alcohol in the diet the more acute features of this reaction have subsided, leaving, however, the characteristic timidity as a habit of life that does not seem to wholly fade out.

It remains to discuss the reproductive histories of our animals and the influence of alcohol upon their progeny, and here we find the most definite results of the entire research.

The first three sexual periods are indicated by interconnecting lines upon the growth chart, Fig. 6, and stars in the course of Topsy's and Tipsy's curves give the number of whelps. At the first period Topsy conceived normally, while Tipsy did not. This may be interpreted as an effect of alcohol in retarding development of the sexual organs, but it occurs rather too often in kennels to be insisted upon.

Topsy's small frame made whelping extremely difficult, and she died as a result of this and lack of proper assistance in time.[1] At the next period, Tipsy is seen to conceive normally, giving birth to seven whelps. Two of these were hare-lipped, and two were born dead. There were four whelps apparently normal in every respect. In Tipsy's next litter, seven in number, three were deformed, two were born dead, and the others proved non-viable.[2] The next litter, of six, had three deformed, two born dead, and all non-viable. Alcohol was discontinued at the beginning of the next gestation in order to ascertain whether the excess of deformity and especially the non-viability of the offspring were a direct nutritional influence of alcohol upon development of embryos *in utero* or attributable to its more general effects upon the maternal organism as a whole.[3] This litter consisted of three whelps, all perfectly formed, but all born dead, and, in spite of very prompt assistance and the best care possible, Tipsy died with them.[4]

On the side of the normal pair there is nothing out of the ordinary to be remarked. There have been eight litters born

[1] It is commonly recognized in kennel management that undersized bitches are likely to give trouble in this way. It was, moreover, my first experience of the kind, necessary assistance was delayed until it was too late.

[2] Milk appeared normal in quality and abundance, but the whelps refused to suck.

[3] Bum had been used for service of bitches in other kennels with uniformly normal results.

[4] At autopsy the walls of the uterus were found to be extremely thin and much infiltrated with fat. Whether this latter condition is to be attributed to alcohol or to the post-partem fever must remain for pathologists to decide. It was not present in the similar case of Topsy I.

FIG. 16. — TIPSY. NOVEMBER, 1895.

FIG. 17. — TOPSY. NOVEMBER, 1895.

up to date, and there is every prospect of as many more. While hare-lips have appeared in three litters, there has been no other deformity, and all the other whelps have been not only viable, but exceptionally vigorous.

For the sake of ready comparison this history of the two pairs is expressed visually in Fig. 18 and again numerically in

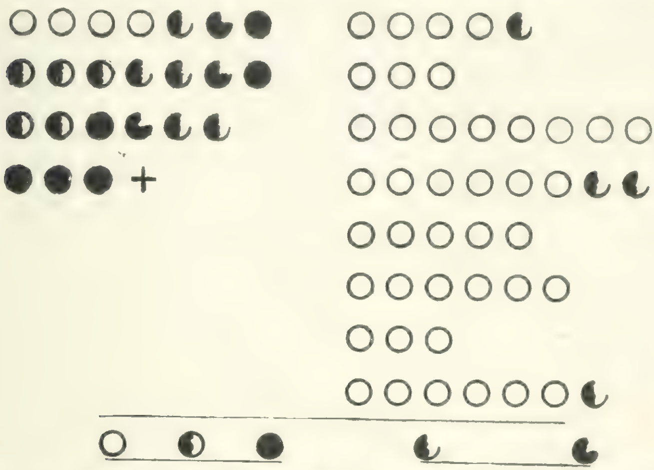


FIG. 19. Comparative tabulation of the offspring of alcoholic and normal pairs of dogs, and of ten inebriate and normal families (after Demme).

Fig. 19, together with a tabulation of strikingly similar results of Professor Demme, obtained from comparative observations upon alcoholic and non-alcoholic families.

INFLUENCE OF ALCOHOL ON PROGENY — DOGS.

	Bum — Tipsy.		Nig Topsy.	
No. of whelps	(7–7–6–3)	23	(5–3–8–8–5–6–3–7)	45
Deformed	(2–3–3–0)	8	(1–0–0–2–0–0–0–1)	4
Born dead	(2–2–2–3)	9	(0–0–0–0–0–0–0–0)	0
Viable	(4–0–0–0)	4 = 17.4%	(4–3–8–5–5–6–3–6)	41 = 90.2%

MEN — DEMME.

	10 Alcoholic families.	10 Normal families.
No. of children	57	61
Deformed	10	2
Idiotic	6	0
Epileptic, choreic	6	(2 Bkwrd) 0
Non-viable	25	3
Normal	10 (1?) = 17%	54 = 88.5%

Frisky was mated with Bum, and has up to the present given birth to six litters. She had been given whiskey from April, 1896, to November, 1897. Their history is as follows: —

Number of whelps	(4–6–4–5–3–5)	27
Deformed	(0–1–0–2–1–2)	6
Born dead	(0–0–1–0–0–0)	1
Viable	(4–5 ?[1]–0–0–0–1)	10 = 37%

Alcohol was also discontinued in her case from November, 1898, but in the two subsequent litters none of the whelps were viable, and only one was viable in the third. In the whiskey, Frisky did not receive as much alcohol as Tipsy, and it was given her case about one year less, but, aside from this, her reproductive history forms a rather close parallel to Tipsy's.

In the matter of non-viability these puppies seemed as inexplicable as many similar cases in man. In weight they were equal to, or exceeded, many of Topsy's viable whelps. They simply would not put forth the least effort to make a live of it. I spent hours milking in their mouths, but to no avail. Examination of the brains of a number of these pups failed to show any traces of medulation: whereas normal whelps killed at birth were found to possess medulated fibres in the sensorimotor areas. No other malformations could be detected, and this seems to be the only clue to their lack of vigor.[2]

Considered in relation to the general literature of the subject, our experiments supply additional evidence to prove that alcohol in small amounts exerts an inhibiting or sedative influence upon certain physiological processes. This is seen in its effect in slowing the growth of yeast, and, while bodily growth has not been interfered with under the conditions of most of our experiments, it is plainly indicated in lowering the normal activities of animals to which it has been administered. The evidence also supports the general conclusions of hygienists that in feats of strength and endurance alcohol should be avoided. Alcoholic dogs also showed diminished resistance to distemper as compared with normal animals under the same kennel management.

On the psychic side kittens showed a sudden collapse, not

[1] Two of these were killed at birth for examination of brains.

[2] I am largely indebted for these results to Dr. Frederick Burk.

only of intelligence, but even of fundamental instincts. While this was soon complicated by disease, nothing so complete was observed in control animals similarly affected. With dogs no impairment of general intelligence was manifested, except that timidity developed as a characteristic psychosis in all those to which alcohol was given. This confirms the results of other experiments on dogs, and also has wide application to the human problem, fear being characteristic of acute alcoholic poisoning and of alcoholic insanities.

Possibly the most important of our results relates to the vigor and normality of offspring. We do not attach much importance to the greater percentage of deformity, since this is of somewhat common occurrence in kennels, and our cases are too few. In respect, however, to vigor and viability of offspring the difference between normal and alcoholic pairs is more striking. This result, it is to be hoped, may stimulate to much more extended research in this important field.

While the experiments are admittedly too few to serve as basis for more definite general conclusions, the possession of control animals adds considerably to their value. And the great amount of time and labor necessary to their prosecution must justify adding the foregoing results to the literature of the subject.

THE INFLUENCE OF ACUTE ALCOHOLISM ON THE NORMAL VITAL RESISTANCE OF RABBITS TO INFECTION.

By A. C. ABBOTT, M. D.,

FIRST ASSISTANT, LABORATORY OF HYGIENE,
UNIVERSITY OF PENNSYLVANIA.

THE INFLUENCE OF ACUTE ALCOHOLISM ON THE NORMAL VITAL RESISTANCE OF RABBITS TO INFECTION.[1]

In the distribution of the several subdivisions of the general question relating to the influence of alcohol upon the physical and moral well-being of those who use it as a beverage, the Committee saw proper to assign to Dr. Abbott for experimental solution the question concerning the influence of alcoholism, acute and chronic, upon the normal vital resistance of animals to various forms of infection.

At the beginning of the work a general scheme of procedure was drawn up that seemed to meet most of the requirements of the problem, but it was found possible to cover only a limited portion of the ground included in this scheme within the time allotted to the investigation.

The lines along which it was proposed to conduct these investigations are as follows: —

1. Determine if the normal vital resistance of animals to infection by the common pathogenic bacteria is demonstrably influenced by either acute or chronic alcoholism, induced through the use of known amounts of pure ethyl alcohol.

2. If any or no effect is observed, determine if the same holds good for animals under the influence of the commoner alcoholic beverages, as beer, wine, whiskey, cordials, etc.

3. Determine if through either acute or chronic alcoholism the germicidal properties of the serum of the blood of animals is materially altered. If so, determine, if possible, the nature of this alteration.

[1] Abstract of a paper which appeared in vol. i., 1896, of the *Journal of Experimental Medicine.*

Investigations bearing upon paragraph 3 have been conducted independently by Dr. Abbott and Dr. Bergey, of the University of Pennsylvania, and published under the title, "The Influence of Alcoholic Intoxication upon certain factors concerned in the Phenomenon of Hæmolysis," in the August

The results presented in this paper refer only to the influence of acute alcoholism upon the resistance of rabbits to infection by the pyogenic cocci — *i. e.* the streptococcus pyogenes (erysipelatos) and the staphylococcus pyogenes aureus — and by the bacillus coli communis. They are in many ways sufficiently instructive to warrant their publication.

The following abstract will serve to present in general the lines along which the study was projected and the results obtained. The details are given in full in the original paper.

A difficulty that arose at the outset was in procuring cultures of pathogenic organisms of suitably diminished virulence without their being at the same time totally devoid of this property. As experience has taught us to expect certain deviations from the usual course of infection when normal animals are inoculated with attenuated cultures, such, for instance, as prolongation of the period of incubation and modification of the pathological lesions, the problem under consideration seemed to be in part most easy of solution through a comparison of results ob-

and September number of the *University of Pennsylvania Medical Bulletin* for 1902.

The points considered by the authors in this paper were : —

1. Does alcohol administered *per os* influence the complement content (Ehrlich's nomenclature) of the blood of rabbits ?

2. Does alcohol similarly administered have an influence upon the specific blood reactions of rabbits already artificially immunized against an alien blood ?

3. Does alcohol similarly administered have any influence upon the process of artificial immunization by an alien blood ?

The results of studies upon these three questions seem to warrant the following conclusions :

1. The daily administration of alcohol *per os* to rabbits brings about a reduction in their circulating blood of the hæmolytic complement.

2. Slight alterations in the normal alkalinity of the blood serum have no demonstrable influence upon the (hæmolytic) complement of the blood of alcoholized rabbits.

3. The diminished reactivating power of the blood of alcoholized rabbits is not due to the presence of small amounts of alcohol as such in the blood.

4. The administration of alcohol to rabbits induces not only a marked reduction in the complement content of their blood, but may cause, at the same time, a reduction in the specific haemolytic receptor in the blood of rabbits artificially immunized against an alien blood.

5. The diminished complement content of the blood of alcoholized rabbits renders the animal more susceptible to the toxic action by an alien blood.

tained by the use of such cultures on groups of alcoholized and non-alcoholized animals. Should such modifications occur in the normal animals as would be anticipated, and an infection not differing from that produced by fully virulent cultures occur in the alcoholized animals, the difference could reasonably be referred to a reduction of vital resistance brought about by the alcohol administered.

To meet the requirements it would perhaps have been best to have employed cultures of organisms that were diminished in virulence to definite degrees of attenuation, such, for instance, as the bacillus anthracis attenuated to the degree of virulence represented by its primary and secondary vaccines. As such material was not available, however, cultures of another sort were used, namely, those that were of a low degree of virulence without this degree being definitely determined.

Again, cultures of organisms were employed, the pathogenic powers of which are usually irregular and uncertain; while in still other tests an effort was made to detect a difference between alcoholized and non-alcoholized animals when inoculated with virulent material, but in very small doses, hoping in this way to demonstrate, by a difference in the period of incubation, a difference of resistance in the animals composing the two groups.

The experiments were made with cultures of streptococcus pyogenes of a low degree of virulence, with normal baccillus coli communis, and with virulent staphylococcus pyogenes aureus, and, as the results to be reported show, with very diverse consequences.

Another difficulty was encountered in regulating the dose of alcohol. The intention was to have the animals daily in a state of intoxication, but it is not easy to decide just when this stage is reached, as the only certain indication of it is inco-ordination of muscular movement. It frequently occurred that when alcohol was given to this stage, the direct effect of the drug was such as gravely to imperil the life of the animal, and in a certain number of instances the animals did not rally from even so few as one or two such administrations. If the dose were diminished, then one could often not be sure that the rabbit was intoxicated.

On the other hand, one encounters occasionally an individual

on which alcoholism to intoxication has apparently no effect upon the general health, and may be prolonged over relatively long periods. One of the animals, for instance, received daily doses of alcohol ranging from 5 to 15 cubic centimetres for one hundred and fourteen days. Its weight at the beginning was 1330 grams and at the end 1350 grams, while during the interval its weight had been as high as 1520 grams and as low as 1090 grams. It died under the administration of 15 grams daily with macroscopic lesions of only the gastric mucous membrane. It is not improbable that the studies upon the effects of smaller, non-intoxicating doses of alcohol will demonstrate the possibility of continuing the administration of the drug over practically an indefinite period, quite to the stage of chronic alcoholism, in a fair proportion of the animals treated in this way.

The individual susceptibility of different animals to the physiological action of alcohol differed in such a way as to require at the beginning a special dose for each individual. It is impossible to maintain throughout a constant relation between body weight and dose necessary to produce the desired effects. For instance, if 5 cubic centimetres of alcohol produce intoxication in a rabbit of 1000 grams weight, it cannot be said that 10 cubic centimetres will necessarily have the like effect in the next rabbit of 2000 grams weight. The dose for the individual can be determined only by experiment.

It frequently occurred that, when the appropriate dose had been determined, its continuous administration over several or more days resulted in very rapid and marked loss in body weight, an indication of the greatest importance, meaning that if the alcohol be continued the animal is practically certain to die. Under these circumstances it becomes necessary either to diminish the dose or cease the administration entirely for a time, until the lost weight is partially or completely recovered. During the interval of rest, as it may be called, the animal is, of course, not daily intoxicated, and while the records of these experiments refer to animals "daily under the influence of alcohol to the stage of intoxication," it will be borne in mind that with many of these animals such periods of rest, varying in duration, were more or less frequently necessary.

As it was impossible to induce the rabbits to take alcohol voluntarily, either with the food or otherwise, it became neces-

sary to administer it through a soft rubber catheter passed down the esophagus into the stomach, and though this was done as gently as possible, the irritation resulting from the repeated passage of the catheter, together with the depressing influence of the drug, was accompanied in a number of instances by intercurrent infections which, from their character and location, can reasonably be traced to insignificant wounds of the mucous surface of the esophagus made when the alcohol was administered.

In only two instances was death positively the result of inspiration of alcohol into the air passages at the time of operation. When such an accident occurs death is practically instantaneous.

The most common macroscopic effect of the direct action of the alcohol was erosion and inflammation of the mucous membrane of the stomach, a condition that was unfortunately present in quite a number of animals, and which complicated matters in such a way as to vitiate considerably the results of the experiments.

When the necessary dose of alcohol was determined, it was always given mixed with an equal quantity of distilled water.

The dose necessary to positively produce intoxication ranged from 5 cubic centimetres to 15 cubic centimetres of pure ethyl alcohol, though the usual dose in rabbits of from 1500 to 1800 grams weight was from 7.5 cubic centimetres to 10 cubic centimetres, doses which, if taken by a man of 150 pounds weight, would be roughly equivalent to from two thirds to five sixths of a pint of absolute alcohol. Notwithstanding this apparently very large amount, animals have repeatedly been encountered on which from 10 to 12, and even 15 cubic centimetres had no visible influence, though the continuance of these doses in many instances was followed by death associated with grave lesions of the gastric mucous membrane.

While rabbits offer conditions in a way favorable to experiments of this character, they are so liable to intercurrent bacterial and protozoal infections as to lead to many irregularities when large numbers of them are used. In the course of this work a number of experiments were seriously vitiated by reason of such complications. The general plan followed in these experiments was to employ groups of equal numbers of animals. All were inoculated in the same way, then to one group alcohol

was given, while to the other no alcohol was administered. They were all then kept under the same conditions of food, etc. Each animal was weighed in the morning before it was fed. In one or two cases the number of "controls" was fewer than that of the alcohol group. Control animals receiving only alcohol were not introduced into each experiment, as the necessary data on this point could always be had by reference to the records of preceding experiments in which the different effects of the drug on different animals was recorded.

Without going further into the particulars, it will suffice to briefly summarize the results of each experiment as follows: —

EXPERIMENT I.

Summary of the results of the intravenous inoculation of rabbits receiving daily doses of alcohol to the stage of intoxication, with bouillon cultures of streptococcus pyogenes obtained from a phlegmonous inflammation in man: —

Of eleven rabbits inoculated intravenously with varying amounts of streptococcus pyogenes, six received daily doses of alcohol for different lengths of time. The remaining five of this group received no alcohol. In addition, two rabbits received only daily doses of alcohol. Of the six inoculated animals that received alcohol, all died after marked loss of weight, and all exhibited lesions referable to the inoculation. One revealed a condition of the liver probably the result of the action of the alcohol.

Of the five inoculated animals to which no alcohol was given, one died, one was killed, and three recovered.

The one that died presented no lesions referable to the inoculation. Cultures revealed the presence of streptococci in the liver mixed with another organism, while the other internal organs were sterile.

The animal that was killed presented no lesions of importance, and its blood and internal organs were found by culture test to be sterile.

Each of the three remaining animals suffered from temporary erysipelas of the ear at the site of needle puncture. They recovered from this, and at the end of 120 days were apparently in good condition, one having gained 330 grams, the other 110 grams, and the other 270 grams in weight.

Of the two animals that were not inoculated, but which received alcohol daily, one died after 114 days with a condition of the gastric mucous membrane referable to the alcohol, the other after 34 days with no macroscopic lesions to account for death.

EXPERIMENT II.

Summary of the results of intravenous inoculation of rabbits, receiving intoxicating doses of alcohol daily, with suspensions of streptococcus pyogenes: —

The eighteen animals employed in this experiment were divided into four groups, and treated as follows: —

Four received intoxicating doses of ethyl alcohol for five days and were then inoculated intravenously with 0.5 cubic centimetre of a suspension of streptococcus pyogenes.

Five received intoxicating doses of methyl alcohol for five days and were then similarly inoculated.

The alcohol was continued in both groups after inoculation until death.

Five received, in addition to the inoculation, daily doses of distilled water, injected into the stomach in the same manner as was the alcohol in the other animals, for fifteen days. After this, alcohol was given to two of them, — to one for two days, to the other for six days, — while the remaining three got nothing from the fifteenth day.

Four were simply inoculated. One of this group received a single dose of alcohol.

The nine latter animals served as controls.

Results. — Of nine inoculated animals to which alcohol was given, seven died with suppurative lesions.

Of nine inoculated animals that received no alcohol until after the fifteenth day, when alcohol was given to two, five died, three were killed, and one was observed for fifty-two days. In only three of the nine were suppurative lesions detected at autopsy.

Of the seven alcohol animals that died, five presented lesions at autopsy that could be attributed to the action of alcohol.

EXPERIMENT III.

Summary of the results of intravenous inoculation of rabbits receiving alcohol daily to the stage of intoxication, with suspensions of bacillus coli communis from human feces: —

Of five rabbits, each of which was inoculated with one cubic centimetre of a suspension in bouillon of bacillus coli communis, and all of which had been receiving alcohol to the stage of intoxication daily for five days, four died in from eighteen to twenty hours and one in eighteen days after inoculation.

None presented lesions referable to the inoculation. One revealed a condition of the gastric mucous membrane that evidently resulted from the direct action of the alcohol. Bacillus coli communis was obtained in cultures from the internal organs of all.

Five rabbits, each of which had been receiving alcohol in doses ranging from 2.5 to 15 cubic centimetres daily for thirty-one days, were inoculated intravenously with the same material in the same amount that was employed in the preceding group.

One died within twenty-four hours after the inoculation.

Four died in from forty-three to fifty-five days after the inoculation.

Three presented at autopsy lesions referable to the inoculation, namely, the condition of the liver, gall bladder, and bile described by Blachstein.[1]

Two presented no lesions attributable to the inoculation.

Two showed a condition of the liver that may possibly have resulted from the prolonged action of the alcohol, while in the remaining three no results of the alcohol were evident.

Two control animals that were inoculated in the same manner with the same material, but which received no alcohol, were alive on the seventy-ninth day after inoculation. By the sixtieth day one had gained 230 grams in weight, while the other, though apparently well, had lost 200 grams in weight.

EXPERIMENT IV.

Summary of the results of inoculation of alcoholized animals with suspensions of bacillus coli communis: —

Three animals received intravenous inoculation of 0.5 cubic centimetre of a suspension of bacillus coli. Immediately afterward the administration of alcohol was begun. One died during the night, and one on the day following the inoculation. Bacil-

[1] Blachstein, "Intravenous Inoculation of Rabbits with the Bacillus Coli Communis and the Bacillus Typhi Abdominalis," *Bulletin of the Johns Hopkins Hospital*, vol. ii. No. 14, July, 1891.

lus coli was found by cultures in the internal organs of both. The third died eight days after inoculation with no characteristic lesions and no colon bacilli in the internal organs. The mucous membrane of the stomach was eroded, and there was a fibrino-purulent pericarditis and pleuritis, evidently the result of an intercurrent infection, probably induced by the repeated passage of the catheter along the esophagus.

Three other rabbits that had been getting alcohol for four days were inoculated in the same manner as the preceding. Two died on the ninth day and one on the eighteenth day following inoculation.

In one, dead on the ninth day, were the characteristic lesions described by Blachstein. There was also present a condition of the stomach that was manifestly the result of the action of the alcohol.

Of the remaining two, in one death ensued from an intercurrent infection, while in the other death was the result of an intestinal intussusception. This latter animal presented erosion of the gastric mucous membrane that was evidently the result of the action of the alcohol.

In both animals that died on the ninth day colon bacilli were present in cultures from the internal organs, while in the one dead on the eighteenth day the blood and internal organs were sterile.

Three control animals were alive and apparently well on the forty-sixth day. One had gained 50 grams, the other 280 grams, while the third had lost 120 grams in weight.

In short, of six alcoholized rabbits inoculated with colon bacilli, all died. One presented characteristic lesions at autopsy. Of three non-alcoholized, control animals, none died.

EXPERIMENT V.

Results of intravenous inoculation of rabbits receiving alcohol, with cultures of staphylococcus pyogenes aureus: —

In this experiment the first inoculation was without effect, and the animals were inoculated a second time after an interval of seven days. Four animals were employed, viz., two alcoholized and two controls. The alcoholized animals died in fourteen and two days, respectively, after the inoculation. Both presented lesions referable to the inoculation, and neither

showed conditions due to the direct action of the alcohol. One control animal died in four days after the first inoculation, while the second died in six days after the second inoculation. To this latter animal alcohol was administered from the time of the second inoculation. Both presented lesions referable to the inoculation, and the one that got alcohol presented also conditions due to the direct action of the alcohol.

This experiment does not demonstrate any material difference between the alcoholized and the non-alcoholized animals as regards their susceptibility to this form of infection.

EXPERIMENT VI.

Subcutaneous inoculation of alcoholized animals with cultures of staphylococcus pyogenes aureus: —

There were four animals in this group, two alcoholized and two controls. In all except one, an alcoholized rabbit, the subcutaneous inoculation was without effect up to the seventh day. On the seventh day the three remaining animals were inoculated again, but this time intravenously.

Results. — One alcoholized animal died in three days after the subcutaneous inoculation. Death was due to pseudo-tuberculosis of the lungs. There was only a trifling area of suppuration at the seat of inoculation. The other alcoholized rabbit died four days after the intravenous inoculation and presented the usual condition of widespread miliary abscess formation. Both control animals died after the intravenous inoculation — the one in seven days, the other in twenty-four hours. The former presented lesions characteristic of the inoculation, while the latter presented no macroscopic lesions at all at autopsy. The former control animal had been given alcohol since the date of its second intravenous inoculation. At autopsy it presented lesions referable to the direct action of the alcohol.

EXPERIMENT VII.

Intraperitoneal inoculation of alcoholized animals with cultures of staphylococcus pyogenes aureus: —

Four animals were employed; two received alcohol and two served as controls.

The animals that exhibited no effects of the intraperitoneal inoculation at the end of a week were reinoculated with the same material, but this time the inoculation was intravenous.

One alcoholized animal died the day following the intraperitoneal inoculation, the other two days after the intravenous inoculation.

In neither were lesions detected that could account for death, or be positively referred to either the inoculation or the alcohol.

Both control animals recovered from the intraperitoneal inoculation, and at the end of a week were inoculated intravenously.

One died two days after this latter inoculation and presented neither mycotic nor alcoholic lesions, death being due to rupture of the gravid uterus, while the other died nine days after intravenous inoculation with abscesses in myocardium and kidneys.

EXPERIMENT VIII.

Intravenous inoculation of alcoholized rabbits with bouillon cultures of staphylococcus pyogenes aureus: —

Of the six inoculated animals to which alcohol was given, three died in less than twenty-four hours and three in forty-eight to seventy-two hours after inoculation. In three, lesions were present that could positively be referred to the inoculation, and in one the condition was doubtful. In two no such lesions could be found.

In five of the six animals a condition of the mucous membrane of the stomach was found that was evidently the result of the direct action of the alcohol.

Of the six inoculated animals that did not get alcohol, three died in less than twenty-four hours, two after five and twelve days, respectively, while the remaining animal was apparently well at the end of forty-three days.

Three of these animals presented lesions that resulted from the inoculation, in one the lesion was doubtful, in one no lesions were detected, and the sixth is still alive.

This experiment demonstrates a slight, though not very important or striking, difference between the course of infection in the two groups.

EXPERIMENT IX.

Subcutaneous inoculation of alcoholized rabbits with cultures of staphylococcus pyogenes aureus: —

Of the six inoculated animals to which alcohol was given, one died during the night following the inoculation ; the remaining five died in from five to fifteen days later.

Two of these animals presented no lesions referable to the inoculation, one presented an extensive local lesion, and three presented a lesion of the pleuræ and pericardium of doubtful significance. This condition was identical in the three animals and consisted of a fibrino-purulent inflammation of practically all the serous surfaces within the thoracic cavity. Cultures from this lesion revealed the presence of a staphylococcus that grew feebly, producing but a very faint, barely perceptible, cream color, and in general gave the impression that it might be an attenuated or enfeebled culture of staphylococcus aureus. It was not studied in detail.

The animals in which this lesion was found died in five, fifteen, and fifteen days, respectively.

The three control animals used in this experiment manifested no ill effects of the treatment. They were alive and well at the end of forty-six days after inoculation.

In none of the six animals that received alcohol was there any macroscopic evidence of the action of the alcohol on the tissues.

EXPERIMENT X.

Intravenous inoculation of alcoholized rabbits with staphylococcus pyogenes aureus attenuated (?) by exposure to chloroform : —

Four animals were used in this experiment.

Of the two inoculated animals to which alcohol was given, one died on the fifth, the other on the second day following the inoculation. One presented a lesion of the kidney positively referable to the inoculation, the other a condition of the peritoneum that probably, though not certainly, resulted from the treatment to which the animal had been subjected.

Both of these animals presented extensive erosions of the gastric mucous membrane that was manifestly the result of the direct action of the alcohol.

Neither of the two control animals evinced any ill effects from the inoculation ; both gained in weight, and at the end of twenty-eight days were eliminated from the experiment as not likely to manifest evidence of infection.

CONCLUSIONS.

The deductions that may be drawn from the results of these experiments are as follows: —

That the normal vital resistance of rabbits to infection by streptococcus pyogenes (erysipelatos) is markedly diminished through the influence of alcohol when given daily to the stage of acute intoxication. That a similar, though by no means so conspicuous, diminution of resistance to infection and intoxication by the bacillus coli communis also occurs in rabbits subjected to the same influences.

And that, while in alcoholized rabbits inoculated in various ways with staphylococcus pyogenes aureus, individual instances of lowered resistance are observed, still it is impossible to say from these experiments that in general a marked difference is noticed between alcoholized and non-alcoholized animals as regards infection by this particular organism.

It is interesting to note that the results of inoculation of alcoholized rabbits with the erysipelas coccus correspond in a way with clinical observations on human beings addicted to the excessive use of alcohol when infected by this organism.

In the course of the work an effort was made to determine if, through the oxidation of alcohol in the tissues to acids of the corresponding chemical group, the increase of susceptibility could be referred to a diminution in the alkalinity of the blood as a result of the presence of such acids. The number of experiments made on this point was too small to justify dogmatic statements, but from what was gathered there is but little evidence in support of this view.

Throughout these experiments, with few exceptions, it will be seen that the alcoholized animals not only showed the effects of the inoculations earlier than did the non-alcoholized rabbits, but in the case of the streptococcus inoculations the lesions produced (formation of miliary abscesses) were much more pronounced than are those that usually follow inoculation with this organism.

With regard to the predisposing influence of the alcohol, one is constrained to believe that it is in most cases the result of structural alterations consequent upon its direct action on the tissues, though in a number of the animals no such alteration

could be made out by macroscopic examination. It is likely, however, in the light of the work of Berkley and of Friedenwald, done under the direction of Professor Welch, in the Pathological Laboratory of the Johns Hopkins University, that a closer histological study of the tissues of these animals would have revealed in all of them structural changes of such a nature as to indicate disturbances of important vital functions of sufficient gravity fully to account for the loss of normal resistance.

The conspicuous influence of the alcohol on the gastric mucous membrane in many of these animals, with the consequent disturbance of nutrition, is undoubtedly the explanation of the marked loss in body weight that was observed in many of the animals employed in these experiments. In this light the susceptibility induced by alcohol to excess is somewhat analogous to that induced by starvation, where we see the resistance of animals to particular forms of infection very markedly diminished.[1]

Memorandum of Unfinished Investigation bearing upon the Influence of Chronic Alcoholism upon the Vital Resistance of Monkeys to Infection.

This investigation was designed to supplement that published in vol. i. of the "Journal of Experimental Medicine," under the title, "The Influence of Acute Alcoholism upon the Vital Resistance of Rabbits to Infection."

The work was begun May 29, 1896, and was discontinued October 3, 1898. During the interval between these dates twenty animals, monkeys, were used. Of this number only eight were living at the time the research was abandoned. Of the twelve monkeys that died, three were purposely killed and nine died of a condition the nature of which could not be determined, even though careful examinations by pathological, and in most instances bacteriological, methods also were made. In none of the animals that died spontaneously was there evidence of tuberculosis or of disease of the digestive tract or kidneys. In this experiment *whiskey*, instead of pure alcohol, was administered.

[1] Since the publication of this paper the results have received confirmation at the hands of Laitinen : *Acta Societatis Scientiarum Fennicæ,* 1900, tome xxix. No. 7 ; also *Zeit. für Hyg. u. Infektionskrankleiten,* 1900, Bd. xxxiv, S. 206, as stated in the paper by Dr. Welch, p. 000.

Of the eight animals that survived the experiment, one, a small rhesus monkey, had been receiving whiskey in varying amounts, and more or less interruptedly, since May 29, 1896, while the remaining seven animals, the so-called "pig tail" macaques, had been getting whiskey under similar circumstances since June 17, 1896.

It is impossible to state accurately the amount of whiskey taken daily by any of these animals, notwithstanding the fact that it was given to them in measured quantities. The reason for this is that in order to get them to take it at all it was necessary to devise a more or less attractive mixture. After several trials a mixture of milk, whiskey, and sugar was found to be most acceptable to them, but even this was not always totally consumed: some of it was at times refused, again some was spilled by the animals in their attempts to drink, while again there were days when they refused the mixture entirely.

It can be stated, however, that after the preliminary stages of the experiment, when the whiskey was begun in very small amounts and gradually increased, it was possible for the small rhesus and the larger macaque monkeys to take 100 and 150 c. c. respectively at a dose without evincing any visible signs of acute alcoholism. Doses much in excess of this (150 and 200 c. c. respectively) were almost certain to cause acute intoxication.

It was also impossible to keep the animals steadily on a fixed dose. At times they exhibited such disinclination to the whiskey that it was often necessary to diminish the dose very much and then gradually increase it again. There were also a number of instances when it seemed advisable to discontinue the whiskey entirely for a time.

It is plain from this that only approximations as to the amount of whiskey taken by the animals can be made.

It is interesting to note that the animals which died did so very early in the experiment, so that we are not inclined to attribute their death to the relatively small amount of alcohol that they were receiving at the time. The health of those that survived was uniformly good; indeed, the appetite in all cases seemed to be increased.

On May 27, 1898, after a period of almost two years on whiskey, it was decided to make an attempt to determine if the vital resistance of the monkeys that had been getting the whiskey

differed in any particular from that of monkeys that had not been, under similar conditions.

To this end the entire growth from five well-developed cultures of bacillus tuberculosis was carefully mixed with 250 c. c. of fresh milk, the alcohol was discontinued, and to each animal 20 cubic centimetres of the milk thus infected was given. In all cases it was entirely consumed.

The animals were then kept under careful observation until October 3, 1898, a period of practically four months. Two days after the ingestion of this mixture of milk and tubercle bacilli one of the original eight monkeys died. It had been suffering from a catarrhal condition and a cough for a week or ten days before the test was made. At autopsy nothing that could be referable to the infected milk was discovered.

The remaining seven animals of the original lot, as well as three newly purchased that served as controls, did not at any time during the four months show the slightest signs of tuberculosis or any other impairment of health.

Two guinea pigs that had received subcutaneous inoculation with the same cultures of bacillus tuberculosis, in order to test its virulence, died of tuberculosis, but only in a very mild and limited form, so that the failure to infect the monkeys may have been due to the use of cultures that were more or less attenuated, though this was not known at the time they were used.

When it was ultimately decided to abandon the experiment, two of the monkeys that had been receiving whiskey for the longest time and in the largest doses were killed, and careful autopsies made.

These revealed the following conditions: —

(1) Large macaque monkey —

On incision through the abdominal walls there appeared a conspicuous amount of yellow fat. There was an unusual deposit of yellow fat over the omentum and about the kidneys. The liver was normal in size, color, and consistence. The kidneys were imbedded in fat, were normal in color and size, smooth on the surface and on section presented no changes recognizable by the naked eye; the capsules of both kidneys were in spots very slightly adherent to the underlying cortex. There was a marked deposit of fat upon the pericardium.

The heart was normal.

Right lung was slightly adherent to the thoracic wall by several small, old adhesions.

There was no evidence of recent or remote tuberculosis.

The lymphatics showed no evidence of disease.

The stomach and intestines were normal.

The spleen was normal.

Microscopic examination of liver and kidneys did not reveal any increase of connective tissue.

(2) Small rhesus monkey —

There was slight excess of moisture in the peritoneal cavity.

Subcutaneous and deeper lymphatics a little large, but not apparently diseased.

Peritoneum, liver, kidneys, spleen, heart, and lungs natural in all respects, in so far as macroscopic examination was concerned.

The animal was well nourished, but did not present the same deposit of fat as was observed in the preceding animal.

Microscopic examination of liver and kidneys did not reveal any increase of interstitial connective tissues.

Reasons for abandoning the investigation: —

(1) From the conditions found in the autopsies just cited, as well as those revealed at autopsies upon the other animals, both those receiving whiskey and those not receiving it, that died during the time of the investigation, there was no evidence that the nutrition of the monkeys was in any way impaired, and the outlook for positive and useful results did not appear as immediately promising.

(2) In view of the fact that not one of the group of animals to which large quantities of tubercle bacilli had been fed, even though these may have been attenuated to some extent, showed the least clinical evidence of tuberculosis or of other impairment of health, the outlook also appeared as unpromising.

(3) Since the animals could only be kept in good health under proper conditions of warmth and dryness, and as the laboratory building was the only place in which these conditions were obtainable, it was soon discovered that the maintenance of so many monkeys in a room in the laboratory became an intolerable nuisance.

(4) The expensive nature of the work, requiring comparatively large sums of money for the purchase and maintenance of animals and for whiskey, exhausted the appropriation that was available for these studies.

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